RESEARCH
PUBLICATION
NO. 5

AERATED LAGOONS

FOR THE

TREATMENT OF CANNERY WASTES

AERATED LAGOONS

FOR THE

TREATMENT OF CANNERY WASTES

A Cooperative Research Project
with the
City of Chatham

June 1963 to August 1964

By

K. Shikaze
Project Engineer

Division of Research
Publication No.5

A. J. Harris
Director

Dr. J. A. Vance
Chairman

D. S. Caverly
General Manager

The Ontario Water Resources Commission

MOE
CHA
AER
APUZ

apuz

ABSTRACT

Pilot plant studies on two parallel diffused air lagoons and one series operated mechanically aerated lagoon together with a waste stabilization pond were carried out at Chatham to treat pea and tomato pack wastes. In the diffused air lagoons, increasing the air supply had less effect on efficiency than decreasing the BOD; the major benefit of the air supply appeared to be in improving circulation. The diffused air lagoons could be satisfactorily loaded up to 350 lb. of BOD per acre per day and produce an effluent of approximately 40 ppm. Some design improvements in the plastic air hose were indicated. The mechanically aerated lagoon, with a retention time of 2.5 days, could treat at least 830 lb. of BOD per acre per day although the sludge produced had poor settling characteristics. Both types of lagoons were resistant to shock loadings. The cannery wastes were deficient in nitrogen but the mechanically aerated lagoon appeared capable of fixing atmospheric nitrogen as a supplemental source. Phosphate in the feed was in excess of the minimum requirements. Eighty and twenty percent phosphate removal were obtained respectively in the diffused and mechanically aerated systems.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

AERATED LAGOONS

FOR THE

TREATMENT OF CANNERY WASTES

1. INTRODUCTION

Many approaches have been used for the treatment of cannery wastes. Among these are spray irrigation, combined treatment with sanitary sewage at the municipal disposal plant, lagooning, chemical precipitation, anaerobic processes, aerobic processes, and various other methods (1, 2, 3, 4, 5, 6). In fact, the amount of work carried out on these various methods is well illustrated in a recent book on industrial waste treatment by Nemerow (7), which cites some 192 references on cannery wastes and their treatment.

The original proposal for the disposal of cannery wastes in Chatham centered around the use of spray irrigation. Spray irrigation is a widely accepted method and is generally an economical and unobjectionable means whereby cannery wastes can be treated. Among the factors influencing the economics and operation of this form of treatment are land costs, cover cropping, soil suitability and design. At Chatham, spray irrigation was ruled out by the high cost of the land required.

In some municipalities cannery wastes have been treated jointly with domestic wastes with reasonable success. However, the seasonal operation of the canneries and the high volumes and waste loads in comparison to domestic wastes result, in many cases, in a much greater capital investment than can be justified. Also, if the ratio of cannery to domestic wastes is very high, the operation of the municipal water pollution control plant may become a problem during the cannery off-season as a result of excessive retention times in the various basins owing to much reduced hydraulic loadings. Another problem could be the proper acclimatization of the activated sludge at the start of each canning season. At Chatham, the ratio of cannery wastes to domestic wastes is approximately two to one; consequently combined treatment appeared economically prohibitive.

One of the earliest and simplest means whereby cannery wastes have been disposed has been by the use of some type of impounding lagoon. In its simplest form, the lagoon merely consists of a diked-off area of land where the wastes are discharged and retained for a period of time before release. These impoundment structures have been referred to by many names; chiefly, oxidation ponds, sewage lagoons or waste stabilization ponds, the latter term being generally used by the OWRC. They may utilize anaerobic or aerobic processes to stabilize the wastes; both processes have been applied to cannery wastes. However, in most cases, the use of the aerobic type is dictated because of the odour problem associated with anaerobic treatment. The assimilation of wastes in waste stabilization ponds is the result of several self-purification phenomena.

The treatment of cannery wastes which are high in volume and strength would require considerable land area if conventional design criteria were followed. Even in the most rationally designed ponds, odours will occur because of the extreme variations in cannery wastes; in many lagoons sodium nitrate is added to reduce the oxygen demand of the waste. However, the use of sodium nitrate results in increased operating costs. Another means whereby objectionable odours can be overcome and aerobic conditions in the lagoon can be maintained is the use of aeration within the lagoon either by mechanical or diffused aeration systems. The work in 1957-58 by W. W. Eckenfelder and D. J. O'Connor showed that an aerated lagoon using diffused air will satisfactorily treat cannery wastes from fruit and baby products (8).

The application of an aerated lagoon system for the treatment of cannery waste at Chatham showed considerable promise. However, the limited information available on the use of this process, particularly for peas and tomatoes, led to the decision to carry out pilot plant studies so that some basis for design could be set up for a full scale treatment works.

2. CONCEPT OF THE AERATED LAGOON

The aerated lagoon is a refinement of the waste stabilization pond and differs only by the presence of a device whereby oxygen is introduced into the process. Therefore, in order to understand the functions within the aerated lagoon, it is necessary first to describe the stabilization of wastes in the conventional waste stabilization pond (9).

The successful operation of the waste stabilization pond is achieved under aerobic conditions produced by the interrelated activities of bacteria, algae, protozoa and higher animals. The relationship is shown in the following cycle:

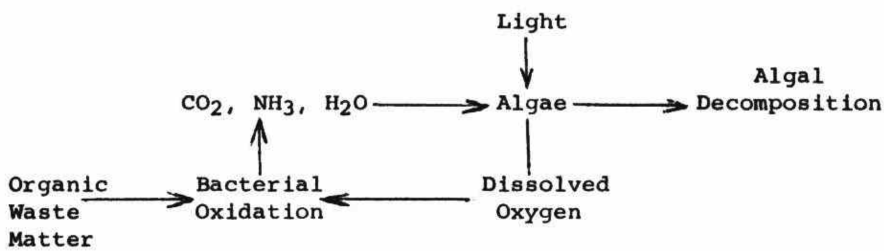


Figure 1

Lagoon Biological Cycle

In the plant-animal cycle of nature in the waste stabilization pond, the algae play a very significant role. In the presence of sunlight, the algae utilize carbon dioxide, water, nitrates and other elements to produce new protoplasm with oxygen as the by-product. This oxygen then becomes available to the bacteria and other microbes which utilize it to stabilize the organic material in the wastes by metabolic processes. Bacterial decomposition of the organic matter results in the production of carbon dioxide, nitrates, water and other trace elements which the algae utilize and thereby complete the cycle.

In the waste stabilization pond, the algae under normal conditions do not supply enough oxygen to maintain a residual oxygen concentration. The other main source of oxygen results from uptake at the surface from the atmosphere. Also depth becomes a limiting factor in the efficiency of the photosynthetic process because light will not penetrate too deeply in algae-laden waters. In general, the optimum depth for waste stabilization ponds ranges from 3 to 5 feet. Therefore, by increasing the depth, providing a means of introducing oxygen into the process, and inducing simultaneous mixing, it should be possible to increase waste loadings to much higher values. By introducing an aeration device, the waste stabilization pond becomes an aerated lagoon capable of handling higher loadings.

The aerated lagoon is an intermediate process, since it can be considered as either a highly loaded waste stabilization pond or a lightly loaded activated sludge plant (10). Most of the studies on aerated lagoons have been based on retention times which ranged from one to ten days; the process under such conditions becomes somewhat similar to complete mixing and total oxidation. Complete mixing produces a turbidity too high to allow light penetration necessary for an abundant algal growth.

3. PILOT PLANT LAYOUT

3. PILOT PLANT LAYOUT

3.1 DESIGN AND CONSTRUCTION OF LAGOONS

3.1.1 Diffused Aeration

The pilot studies in Chatham centered around the design of two aerated lagoons with retention periods of up to a month. Diffused air was to be introduced by means of perforated lead-keeled plastic tubing (11, 12). This tubing was fairly new on the market and its limitations in cannery waste treatment were not fully realized; tests under actual conditions were necessary. It was also necessary to determine the loadings possible under conditions of greater lagoon depth and increased retention period. With these factors in mind, the OWRC requested the consultant for the City of Chatham, Todgham and Case Limited, to prepare plans for the pilot study on the treatment of cannery wastes in aerated lagoons according to these requirements.

The aeration hose manufacturer, on being approached, had a number of his own design specialties to suggest, one of which concerned the utilization of a bi-level aerated lagoon where the bottom levels of a 20-foot deep lagoon would settle out sludge for recirculation. It was asserted that odours from any anaerobic activity would be avoided by aeration of the upper water layers using aeration hose suspended at an intermediate depth. In consideration of these suggestions, a small pit was dug below the aerated depth near the influent end of lagoon #2. It was to be closely observed as to whether this sub-basin would be able to accumulate any significant sludge quantities.

3.1.2 Mechanical Aeration

The inclusion of a mechanically aerated lagoon using a surface aerator was also decided upon as a promising aeration system. Aeration determinations had been made upon just such a unit by the Purification Processes Branch of the OWRC (13). This lagoon would have short retention times however.

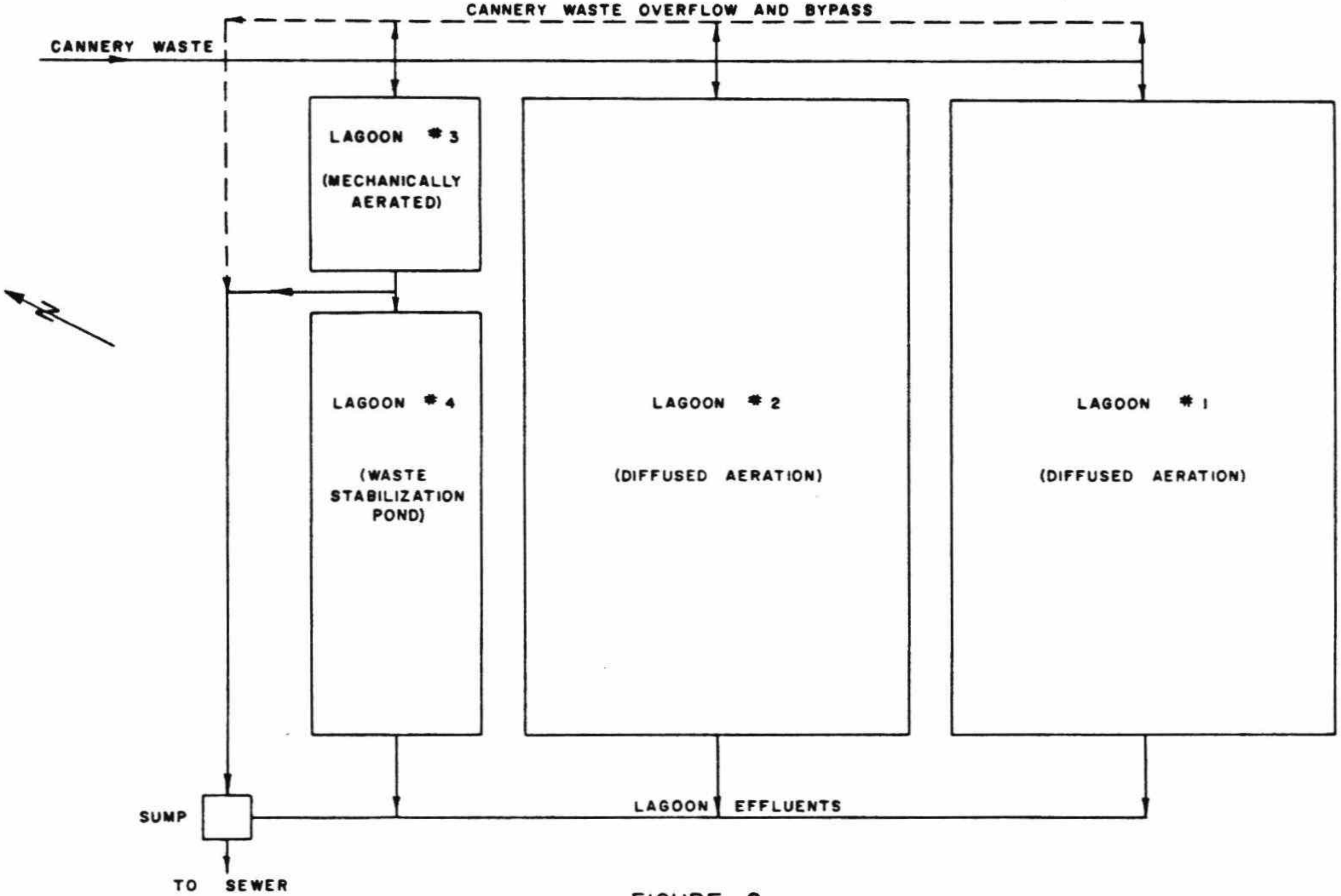


FIGURE 2

SCHEMATIC DIAGRAM OF PILOT STUDY LAGOONS - CHATHAM

As shown by Figure 2, four lagoons were laid out to provide three parallel alternative treatment systems for the cannery wastes.

3.1.3 Construction

Construction was begun in the latter part of May, being scheduled for completion by June 10th. The work schedule extended to June 17th. Fortunately, this date proved on time for the beginning of cannery processing on June 24th as adverse weather had retarded the season's pea crop by two weeks.

3.2 FEED AND EFFLUENT

3.2.1 Transport of Cannery Wastes

Cannery waste feed for the lagoons was obtained from a cannery sewer manhole 800 feet from the lagoon area. At the manhole the sewer was partially blocked to create a small sump for a float controlled pump intake. A pumping station was then set up over the manhole to withdraw waste for use in the lagoons. A wide-mesh screen about the pump intake excluded coarse materials of a damaging nature to the pumping system. A four-inch black polyvinylchloride hose, entrenched one foot below ground level, conveyed the wastes under pump pressure to the control weir boxes at the head of the three lagoon systems.

3.2.2 Waste Metering

Gate valves at the weir boxes controlled both the wastes which entered the boxes and the levels of liquid behind the weirs. V-notched weirs metered the volume of feed to the lagoons. By-passed wastes joined a ditch about the lagoon embankment perimeter.

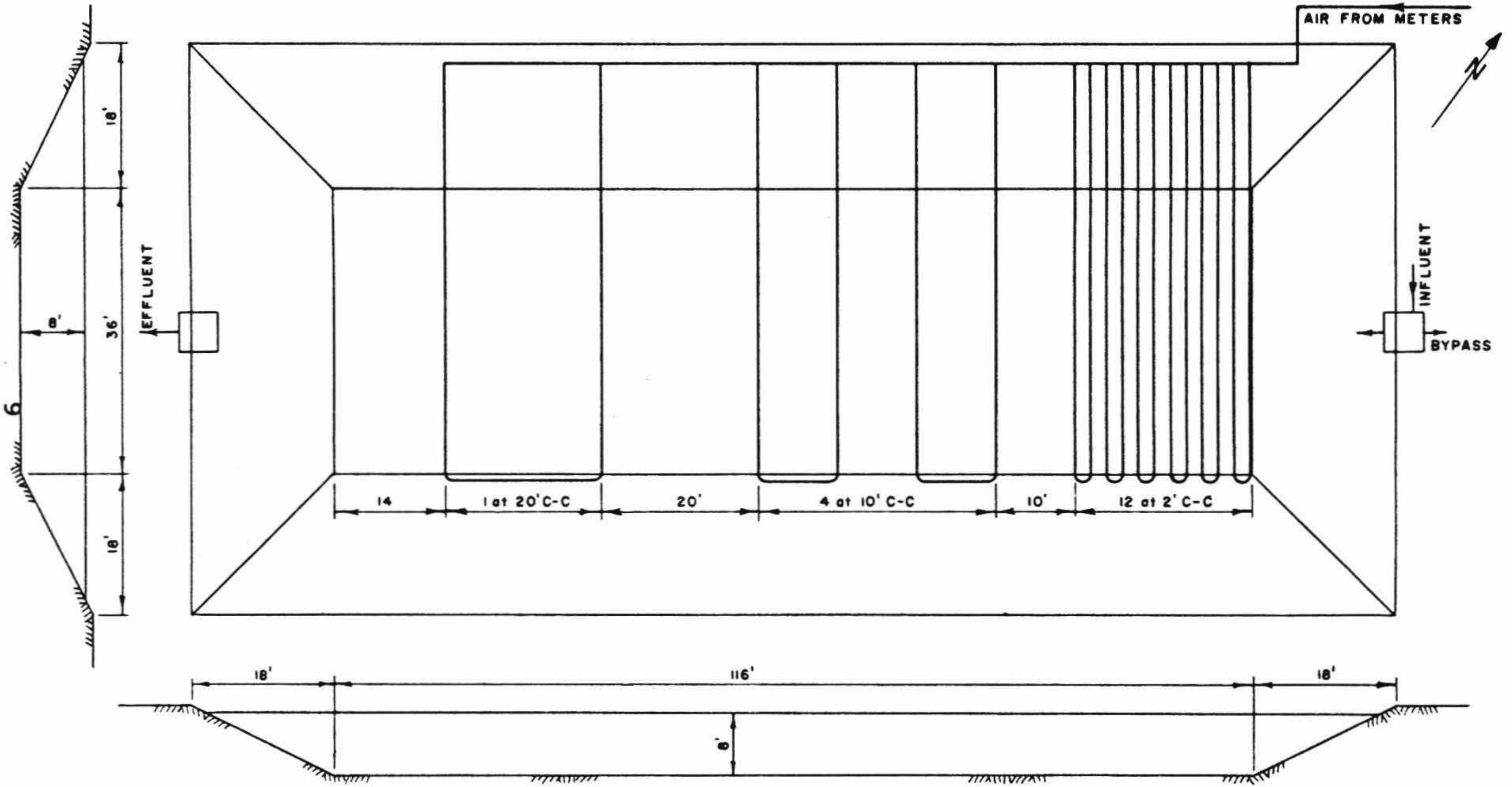


FIGURE 3

LAGOON #1 (DIFFUSED AERATION)

CONSTANT 8 FT. DEPTH

3.2.3 Drainage System

Effluents from lagoons 1, 2, and 4 joined the perimeter drainage system along with the by-passed wastes. This drainage ditch system flowed to a float controlled pump-cleared sump from which both by-passed wastes and effluent were returned to the original sewer source.

3.3 LAGOON #1, DIFFUSED AERATION

3.3.1 Size

As shown in Figure 3, lagoon #1 was designed to have a surface 152 feet long and 72 feet wide when filled to its eight-foot deep capacity. The sides of the lagoon sloped down towards the flat bottom at a 2 to 1 slope.

3.3.2 Air Diffusers

Aeration was supplied from the flat bottom of the lagoon using a perforated lead-keeled plastic air hose system. This tubing was laid out in long U-shaped loops across the width of the bottom sector, and each end was connected to a four-inch plastic air line header extending along the length of the lagoon. Connection of each loop lateral to the header was made through 20-foot lengths of unperforated hose for conveying the entire air supply to the 8-foot deep region of the lagoon. The spacing of aeration grid laterals was closer together at the head of the lagoon than at the effluent end as follows:

12	laterals	at	2	feet	centre	to	centre
4	"	"	10	"	"	"	"
2	"	"	20	"	"	"	"

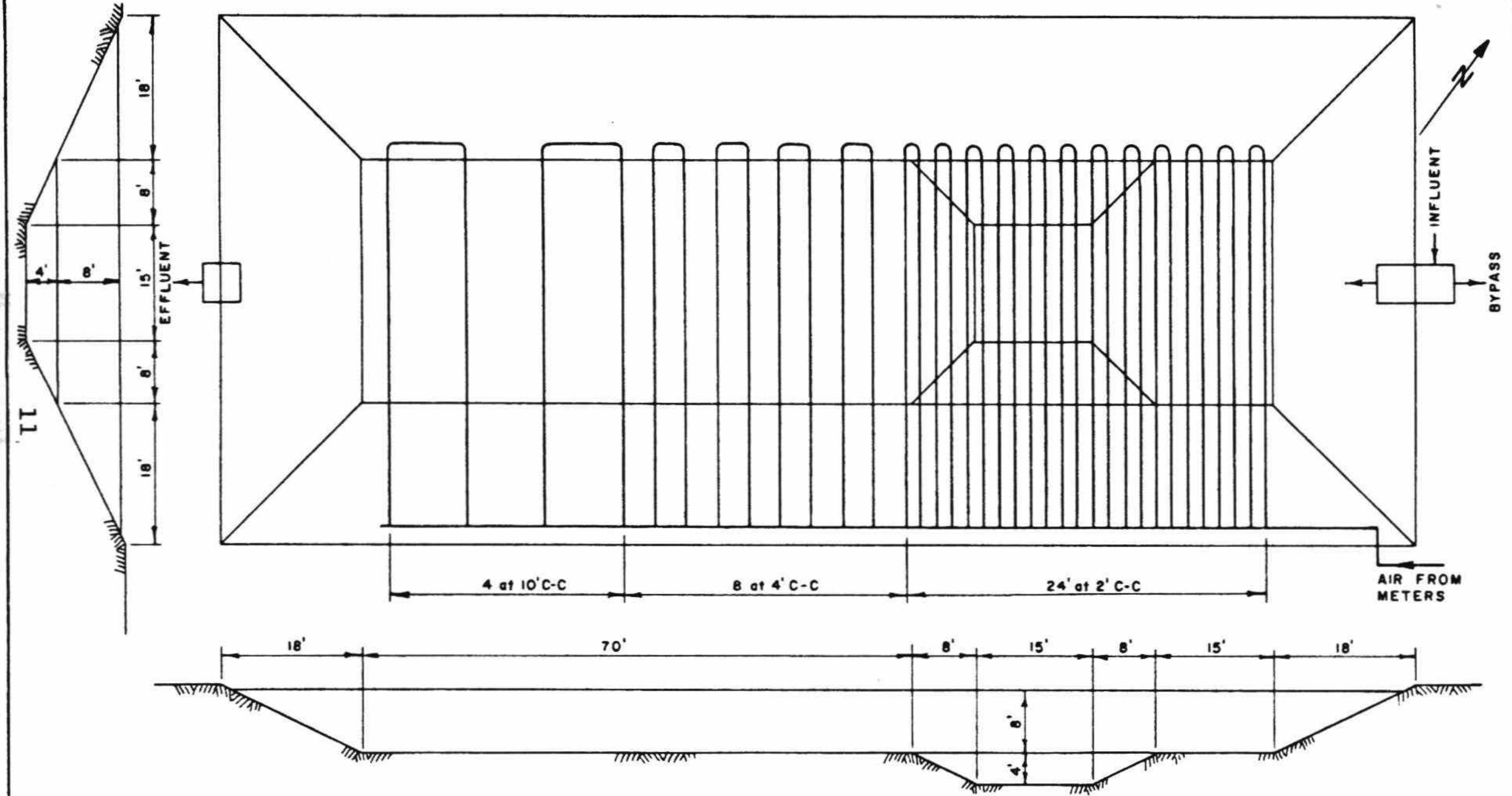


FIGURE 4

LAGOON #2 (DIFFUSED AERATION)

BI - LEVEL: 8' & 12' DEEP

3.4 LAGOON #2, DIFFUSED AERATION

3.4.1 Size

With respect to lagoon #1, lagoon #2 (Figure 4) had nearly identical surface area (152 feet by 71 feet) depth (8 feet) and underwater side slopes (1 to 2).

3.4.2 Anaerobic Basin

In addition, however, an unaerated 12-foot deep basin on part of the lagoon bottom was provided for concentrating settleable solids. This 15-foot square, 12-foot deep basin was bordered by the standard 1:2 sloped sides rising to the 8-foot level. The near slope of this basin began 31 feet from the inlet end of the pond.

3.4.3 Air Diffusers

The aeration hose system was similar to that of lagoon #1. There were however twice as many aeration loops provided for lagoon #2. The aeration grid was suspended at the 8-foot level above the 15-foot square deeper section so that the bottom four feet of the basin remained unaerated by any direct action. Aeration hose laterals were concentrated from the inlet end of the lagoon as follows:

24	laterals	at	2	feet	centre	to	centre
8	"	"	4	"	"	"	"
4	"	"	10	"	"	"	"

3.5 AERATION SYSTEM FOR LAGOONS #1 AND 2

3.5.1 Air Volume Requirements

With a total of 1,700 feet of aeration tubing being laid on the bottoms of the two diffused air lagoons, the air supply requirements were indicated to be in the range of 2 cfm per 100 feet of tubing or a total of 34 cfm at approximately 5 to 6 psig pressure. To supply this air, a rebuilt positive displacement blower rated by the manufacturer as delivering

56 cfm at 1,530 rpm and 7 psi was put into service. After several weeks operation, this blower unit became overloaded due to back-pressure development. The blower speed had to be reduced from 1,530 rpm down to 1,120 rpm as back-pressure in the lines climbed steadily to 12.5 psig. At 1,120 rpm, the blower capacity was 35 cfm. A high pressure 10 HP model 6H Sutorbilt blower rated at 157 cfm at 10 psi and 1,530 rpm was installed on October 9, 1963 to overcome the excessive power demands developed in the aeration system.

3.5.2 Air Metering

Air from the blower was fed into a bank of six natural gas meters calibrated and installed at the site by the local gas company. Three meters in parallel determined the air feed to each aerated lagoon.

3.5.3 Air Distribution

From the meters the air was passed down two 4-inch air line headers of black polyvinylchloride composition. The headers were submerged along the lengths of their respective lagoons near the edge of the water.

By means of two-foot centre to centre taps located on the air supply headers, connections were made with the aeration laterals on the lagoon bottoms. Lengths of black polyvinylchloride hose leads, 1/2 inch in diameter connected the header supply to the lead-keeled aeration hose. The latter hose had an internal diameter of 1/2 inch, a main wall thickness of 0.05 inches, and a sealed-on lead keel of 0.20 inch diameter. Topside of the hose was perforated by 1/10 inch, longitudinally-oriented slits every 1-5/8 inches centre to centre. The hose was extruded of a green, compounded polyethylene material.

A 25 psig capacity pressure gauge was located on each header. These meters were calibrated with a mercury manometer standardization gauge as indicated by the following table.

Table A

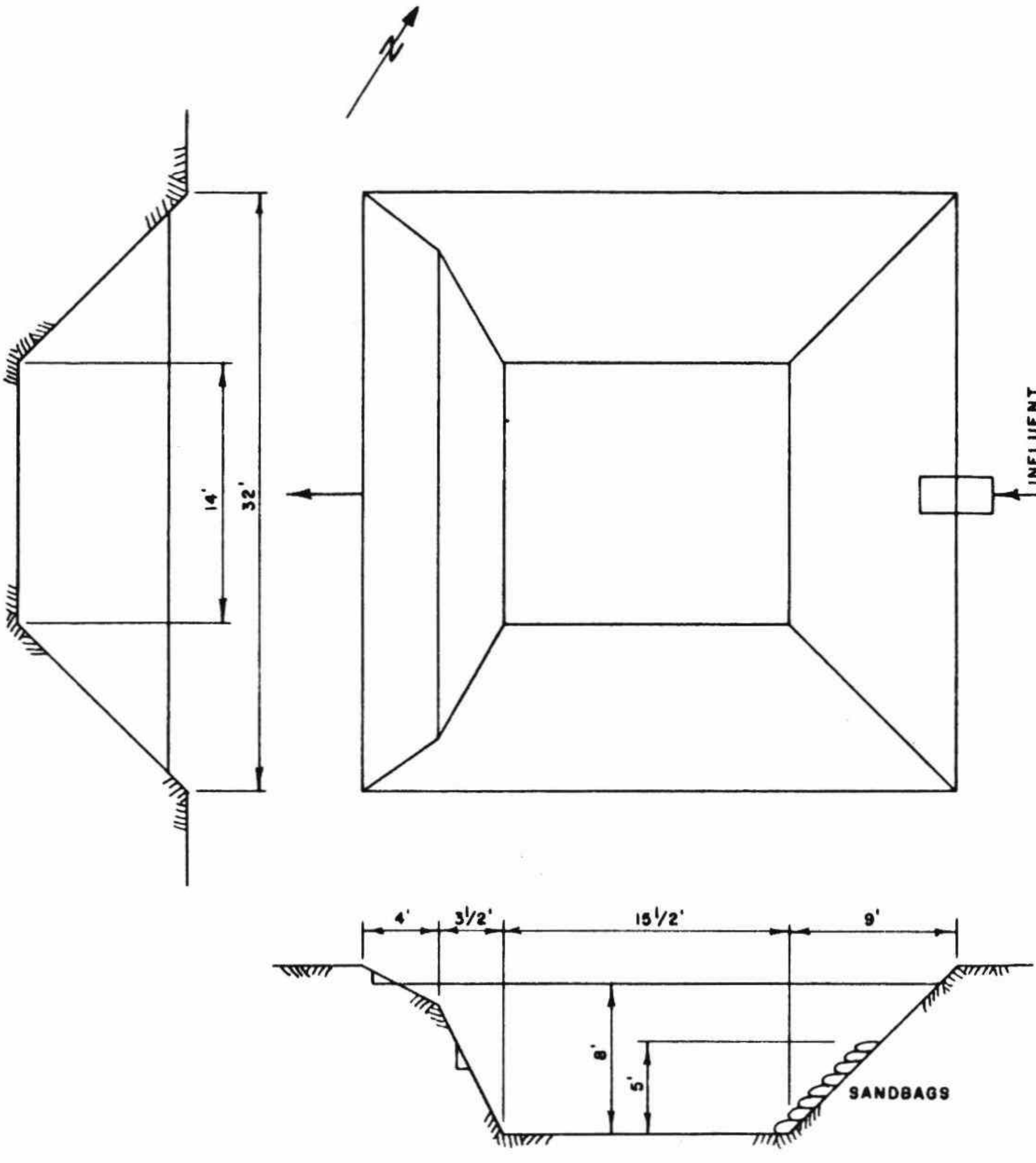
Calibration of Air Gauges

Standard psig	Gauge A psig reading	Gauge B psig reading
1	-	-
2	1.9	2.0
3	2.9	2.9
4	3.9	4.0
5	4.9	4.9
6	5.9	6.0
7	7.0	7.1
8	8.0	8.1
9	9.0	9.0
10	10.0	10.1
11	11.0	11.0
12	12.2	12.0
13	12.9	12.9
14	14.0	14.0
15	14.9	14.9
17	17.0	16.7
20	20.0	19.8

3.6 LAGOON #3, MECHANICALLY AERATED

3.6.1 Size

This lagoon shown in Figure 5 measured 32 feet square at the full 8-foot depth capacity. Relatively steep sides were constructed for this lagoon by the sandbagging of the slopes of the inside wall. A 15-foot square area served as the lagoon bottom. To prevent bank erosion by surface wave action, 0.008 inch polyethylene sheeting was anchored about water level on all four sides.



NOTE
4' WIDE POLYETHYLENE FILM AROUND PERIMETER OF LAGOON AT SURFACE TO PREVENT EROSION.

FIGURE 5
LAGOON #3 (MECHANICALLY AERATED
SURFACE AERATOR 3' DIA. – 3 H.P.

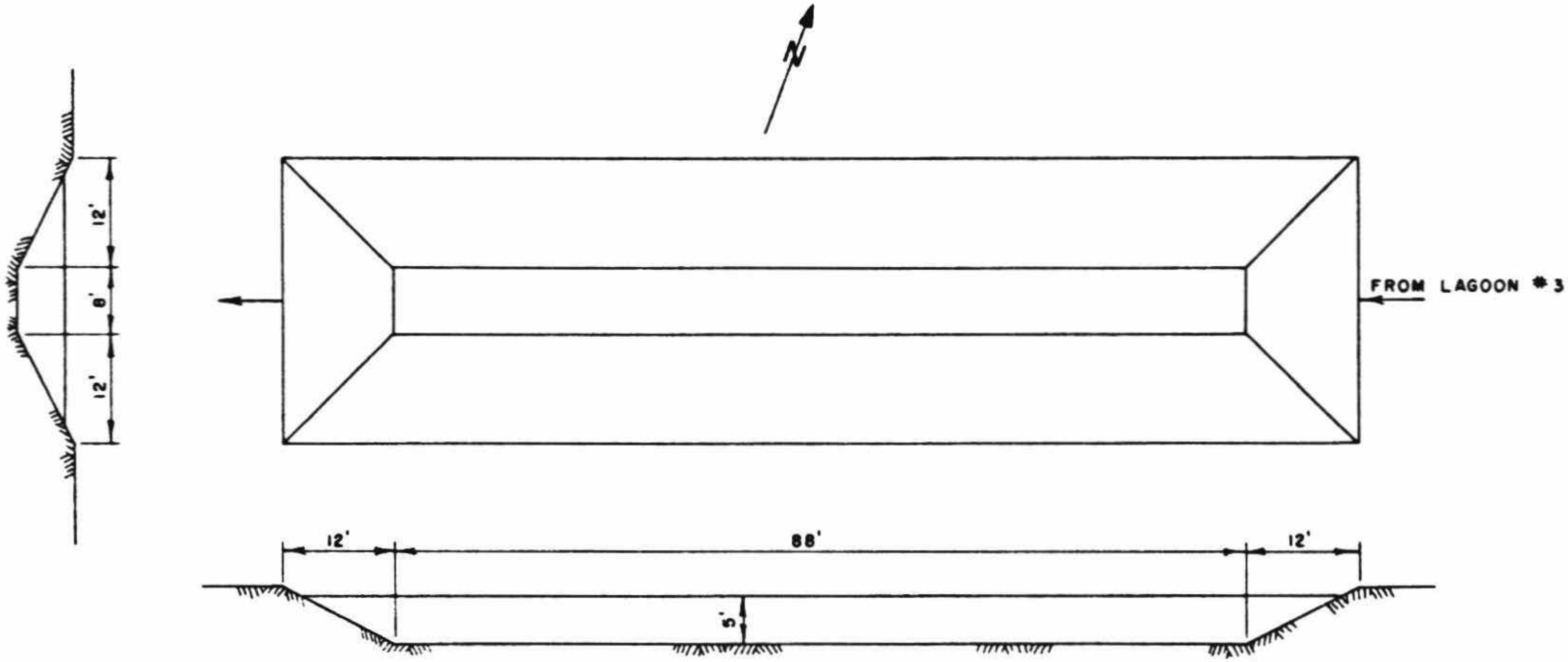


FIGURE 6

LAGOON #4 WASTE STABILIZATION POND

3.6.2 Surface Aerator

A 3.5 foot diameter Simon-Carves surface aerator wheel powered by a 3 HP motor through a variable speed drive set for 75 rpm aerator speed provided the aeration capacity. The aerator was centred on the lagoon's surface by a piling-mounted platform. Immersion of the device was controllable by an elevator mounting. Previous rating of the aerator device at the OWRC Laboratories indicated the unit was capable of delivering four pounds of oxygen per hour to uncontaminated tap water.

3.7 LAGOON #4, WASTE STABILIZATION POND

3.7.1 Size

As illustrated by Figure 6, the waste stabilization pond was relatively small with a 112 by 32 feet surface area (0.06 acre) and a 5-foot depth.

3.7.2 Feed

Waste feed was obtained from lagoon #3 effluent. The latter's effluent could also be by-passed around lagoon #4 to control the waste loading.

3.8 PHOTOGRAPHS

Figures 7 to 14 on the following pages illustrate the construction features and operation of the pilot lagoons.

Figure 7

Exposed view of lagoon #2 from the effluent end. Support rods for aeration tubing over the 12-foot deep section are visible in the centre.

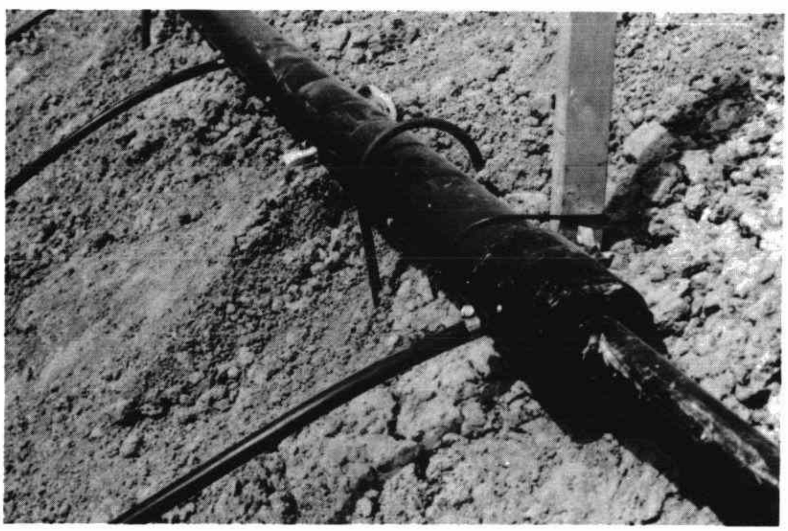


Figure 8

Close-up of air supply connections showing compressor line and lateral junctions with the air header.

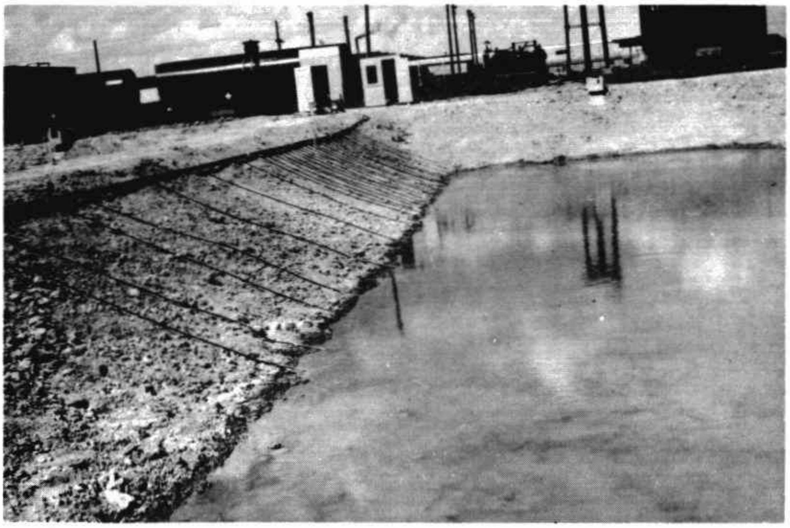


Figure 9

View towards influent end of lagoon #1 prior to waste introduction. One foot of municipal water is present.

Figure 10

Aeration patterns on lagoon #1 during initial pea pack operations. View toward effluent end; water depth 4½ feet.

Figure 11

Aeration patterns on lagoon #2 during initial pea pack operations. View shows the more concentrated aeration at the influent end.

Figure 12

Pre-operational view of lagoon #3 showing aerator mounting assembly. Overflow trough is visible at right.

Figure 13
Operation of Lagoon #3 during pea pack.

Figure 14
Operation of lagoon #3 during tomato pack.

4. SAMPLING

4. SAMPLING

4.1 PERIOD

The sampling period throughout this study was from 12 midnight to 12 noon. This twelve hour period was chosen for composite sampling because it was felt that it would give the most representative sample of the cannery wastes. Wastes from the processing and the clean-up period in the cannery were represented in most of the composite samples taken. The composite samples consisted of thirteen equal aliquots taken hourly over the twelve hour period. However, in the periods between and following each packing operation, stable lagoon conditions permitted the use of grab sampling instead.

4.2 LOCATION

During both packs daily samples were taken of the influent waste and of the effluent end of both lagoons. Since the larger lagoons did not discharge any effluent until late in the tomato season, the samples taken at the effluent end were technically not effluent samples.

4.3 GRABS

Grab samples were also taken from various points of each of the four lagoons twice each day at midnight and at 10 a.m.

4.4 ALGAE

Algae samples were collected and preserved with formaldehyde for identification and enumeration at Toronto as frequently as laboratory facilities would permit. Samples were concentrated about periods of significant algal growth activity. Weekly samples were obtained during some period of the tomato pack operations.

4.5 SLUDGE

A number of attempts to obtain bottom sludge samples was made using bottom sampling equipment such as an Ekman dredge and various bottom coring devices. Generally no significant sludge could be located even in the deep basin of lagoon #2. However, lagoon #3 was an exception to the rule.

5. ANALYSES

5. ANALYSES

5.1 AT CHATHAM WATERWORKS

The daily composite samples were analysed at the laboratory set up at the Chatham Water Works. The following analyses were carried out: BOD, COD, and total, dissolved and suspended solids.

5.2 AT OWRC LABORATORY

These same samples were also sent periodically to the OWRC Laboratories in Toronto for further analyses for free ammonia, nitrates, nitrites, total Kjeldahl, nitrogen, phosphates, volatile solids, carbonate and bicarbonate alkalinity, carbon dioxide, hardness, chloride and sulphate.

5.3 ON SITE

The analyses performed on the grab samples included dissolved oxygen, pH, temperature, and settleable solids. Facilities to carry out these tests were made available at the pilot study site.

5.4 ALGAE

Algal samples were submitted for standard algae counting procedures. Result reporting was confined to the main dominant algal species in the samples. A backlog of this analytical work maintained laboratory activities on the samples into early 1964; however, formaldehyde preservative was effective for the completion of this work.

6. OPERATIONAL RESULTS

6. OPERATIONAL RESULTS

6.1 PEA PACK WASTE FEED

6.1.1 Irregularity

The regularity and consistency of pea pack wastes for the pilot study was poor. The 1963 pea harvest was irregular probably as a result of the unusually dry season, and packing operations at the plant were consequently affected. The resultant intermittent waste discharge from the cannery proved to be a major obstacle in the establishment of a regular loading schedule for the pilot lagoons.

6.1.2 Processing Periods

Waste flow began with a six-hour processing period on June 21st, followed by two weeks steady processing from June 24th to July 5th. Thereafter, wastes became intermittent for a period lasting until the end of July. Steady processing operations at the cannery consisted of two ten-hour shifts followed by a four-hour clean-up break from 3 a.m. to 7 a.m.

6.1.3 Analytical Results

Table 1, Appendix A, details the analytical results of daily 12-hour composite samples of this waste. It should be noted that the waste feed was at all times in a fresh, aerobic condition with available dissolved oxygen still present.

6.2 TOMATO PACK WASTE FEED

6.2.1 Processing Period

Tomato pack feed to the system began with two single day runs on August 5th and 21st. On August 27th steady processing commenced and continued until October 18th, with the exception of occasional week-end shutdowns. Steady processing hours were similar to those for pea pack operations.

6.2.2 Type of Waste

Wastes from tomato processing were of two types; one was derived from the canning of juice, and the other from the production of soup. Soup production was limited to the period from September 30th to the end of the tomato pack.

6.2.3 Analytical Results

The results of daily composite samples as shown in Table 2, Appendix A, illustrate that soup wastes contained higher organic loadings, probably as a consequence of thickening ingredients added to soup products. Tomato wastes generally arrived at the lagoons with an even higher dissolved oxygen content than the corresponding pea wastes.

6.2.4 Supplementary Wastes

During certain periods in September, lima beans freeze-processing was carried on simultaneously with tomato canning operations. The lima bean wastes, however, being limited in quantity and analytically similar in waste composition, exerted minimal influence upon the overall test results.

6.2.5 Tomato Seeds

One feature of the tomato wastes was the presence of discarded seeds. The tomato seed accumulations in the weir boxes of the pilot plant system necessitated daily clean-out. In addition, seeds tended to collect in sludge banks just below the weir discharges into the lagoons.

6.3 LAGOON #1 (Diffused Aeration)

6.3.1 Dilution Water

Operation of lagoon #1 commenced with the initial filling to a 36-inch depth (about 80,000 gallons) with city water. Prior to the start of tomato pack operations, additional municipal water was added to the pond in order to yield an effluent

overflow during the tomato pack; between August 9th and 13th the lagoon level was elevated from 62 inches or 197,000 gallons to 79 inches or 275,000 gallons.

6.3.2 Algal Growth

A vigorous algal growth developed in the water even before the introduction of any wastes. During periods of waste loading, the green coloration of the water tended to fade to a light brown or a bluish hue. The green colour however usually returned after heavy waste applications had ceased.

6.3.3 Variation in Loading

Waste loadings of the lagoons tended to be highly variable due in part to the intermittent nature of some of the wastes and in part to the need to test the units to their fullest capacities. Tables 3, 4, 5, and 6, Appendix A, detail analytical and operating results for lagoon #1 during and after the pea pack operations.

6.3.4 Overflow

During the pea pack, effluent overflow did not occur from the pond. At the maximum depth of 66 inches, the water level was still 30 inches below the overflow. Effluent samples during period of no overflow were taken from the effluent end of the lagoon. During the tomato pack, the overflow level was reached for brief periods only; October 1st to 9th, and October 17th and 18th.

6.3.5 Losses

Average volume losses due to evaporation and seepage were estimated to exceed 5,000 gallons per day at times. Seepage through the lagoon berms became more evident at the higher water levels.

6.3.6 Aeration Tube Pore Clogging

Continuous difficulty was noted with the aeration tubing system of the lagoon. The pores were constantly plugging and causing excessive back-pressure loads upon the blower unit. A number of measures had to be employed to revive the dwindling air supply.

6.3.7 Odours

The occurrence of odours associated with lagoon #1 was limited to heavy loading periods during tomato pack operations. Mild septic odours were noted from this lagoon on two occasions; October 7th and 8th, and October 19th to 22nd.

6.4 LAGOON #2 (Diffused Aeration with Sub Bottom Pit)

6.4.1 Dilution Water

This lagoon was also filled with 36 inches of municipal water at the beginning. During the period between packs from August 9th to 13th, municipal water was added to raise the level from 62 inches or 212,000 gallons to 78 inches or 289,000 gallons.

6.4.2 Algal Growth

The original municipal water was very soon populated with algae and a green colour predominated mainly during periods of low waste loading. Heavy waste loadings tended to produce brown and blue colorations to the water.

6.4.3 Variation in Loadings

Waste loadings were similarly affected by waste fluctuations and availability, as with lagoon #1. This lagoon however was subjected to higher waste loadings particularly during tomato pack operations. Tables 7, 8, 9, and 10, Appendix A, detail the operational data for this lagoon.

6.4.4 Overflow

Overflow of an effluent did not occur during the pea pack operations. The increase in the water level obtained from the addition of municipal water assisted in obtaining an overflow from September 28th to October 9th and on October 18th.

6.4.5 Aeration Tube Pore Clogging

The aeration tubing in this lagoon also became plugged paralleling the misfortunes of lagoon #1. Lack of a reliable air distribution was a factor in upsetting a schedule for increased waste loadings that could be applied over a period of time.

6.4.6 Odours

After high waste loadings, septic odours did occur on a number of occasions during the tomato pack; namely, October 5th to 10th, mildly from October 10th to 12th and from October 17th to 21st, and slightly on October 21st and 22nd.

6.5 AERATION SYSTEM PROBLEMS, LAGOONS #1 AND #2

6.5.1 Clogging

A great deal of difficulty was encountered in maintaining an adequate air supply to the two diffused air lagoons through the use of the submerged aeration plastic hose. The pores in the tube proved extremely susceptible to clogging.

6.5.2 Loss of Air Volume

Inside of four weeks of initial operation, the air delivered to both lagoons dropped to 12-1/2 cfm and, by the end of the study, to less than an estimated 3 cfm.

6.5.3 Pressure Build-up

Simultaneously, the back pressure increased in the system. The initial 3-1/2 psig air pressure, as recorded by two calibrated air pressure gauges, eventually built up to values exceeding 12-1/2 psig. This increasing load eventually overwhelmed the initially satisfactory blower unit.

6.5.4 Scale Composition

As detailed in Appendix B, subsequent examination of clogged air pores demonstrated that minute quantities of hardness scale had built up in the air slits.

6.5.5 Remedial Measures

Throughout the study, attempts to revamp the air hose system were made. One method was to supercharge the submerged hose system with 40 psig air from a mobile compressor unit brought in for the task. This technique was employed with some usefulness on the following dates: July 8, 16, August 6, 17, 21, 23 and September 4. Typically, this treatment tended to reduce back pressure from the 11 psig range to about 8 psig. By September 13th, a valve arrangement on the blower air supply line permitted the diversion of almost all the air from the blower to each lagoon in turn. While this method of supercharging was not as forceful, it could be performed daily as required.

More significant, however, was the effect of re-cutting the air slits in some of the tubing. When the manufacturer of the tubing visited the lagoon site on September 18, 1963 with a special re-cutting device, some of the tubing was lifted and re-cut. On this occasion back pressure dropped from 10.8 psig to 3.5 psig and the localized air distribution appeared very much improved. Also on September 19th, chlorine gas was passed through a number of lines over the deep section of lagoon #2 with considerable observed benefit. Back pressure however could not be lowered much further than had already been achieved.

Despite the above measures taken to correct the air distribution problem, line back pressure continued to rise as initially noted, causing certain equipment breakdown.

6.5.6 Scale Removal Experiments

Beginning on November 25th, after waste treatment had ended, a special investigation was made as to the practicability of using chemical treatment methods to clean the aeration tubing. Appendix B outlines promising results using chlorine gas and hydrochloric acid in particular.

6.5.7 Blower Shutdowns

On a number of occasions, the original blower unit became overheated due to back pressures and had to be shut down to cool. An extra air line was later used to help cool the unit. On August 27th, the blower was shut down for motor repairs and on September 2nd, a defective 2 KVA transformer was replaced with a 3 KVA unit. During the repairs a mobile air compressor was obtained to maintain a suitable air supply. On October 9th, a 10 HP blower unit replaced the original blower at the site.

6.6 LAGOON #3 (Mechanically Aerated)

6.6.1 Initial Start-up

This lagoon was filled to the 74 inch level with municipal water to check out the mechanical equipment. Waste flow raised the liquid level to 85 inches where an overflow was maintained throughout most of the waste loading period of both packs.

6.6.2 Aerator Wheel

The aerator wheel ran at full submergence (adjusted to water levels) throughout the tests at approximately 75 rpm. This immersion would require a brake horsepower of at least 0.96 and a probable motor horsepower in the range of 1.5 to 1.8 for the 3 HP motor used. It was possible to maintain full aeration during the lowering of levels between and after packs, since the aerator was mounted on an adjustable elevator frame.

6.6.3 Foam

Foam as a result of the aerators action was frequently observed on the lagoon surface, following the clean-up period at the cannery, when caustic and detergent wastes were being discharged. Foam material often broke down to form an unsightly border of floating scum around the edge of the lagoon.

6.6.4 Sludge

The sludge carried over in the effluent generally did not have good settling characteristics. It was very light and often permeated with filamentous organisms. On the other hand, the bottom of the lagoon tended to accumulate heavy solid material, such as tomato seeds, which by the end of all operations reached approximately 18 inches in depth.

6.6.5 Loading Characteristics

In terms of pounds of BOD per acre, this lagoon far exceeded the loading of the diffused air lagoons. Despite this, no odours were produced during operations, and the dissolved oxygen content was always high. The odour was generally that of the raw wastes. Algal growth was only possible after the shutdown of the aerator at the end of the canning season.

6.7 LAGOON #4 (Conventional Waste Stabilization Pond)

6.7.1 Source of Waste

The source of waste influent for this pond was the effluent of the mechanically aerated lagoon (#3). However, due to the heavy loadings of lagoon #3 and the conventional lagoon's small size, only a small proportion of the former's effluent could be accepted.

6.7.2 Character of Influent

This influent differed from that of the other three lagoons in that it was already partially treated. As a result of the action of lagoon #3, the raw waste BOD concentrations had been reduced, and some of the heavier solids had settled out. In addition, extensive flocs of filamentous bacteria which had developed in the previous lagoon were carried over as poor settling solids. The feed for lagoon #4 was maintained always in an aerated condition by lagoon #3's mechanical aerator.

6.7.3 Hydraulic Loading

On June 25th, feed from lagoon #3 commenced into 15 inches (7,800 gallons) of algae-populated water in lagoon #4. Because of an effluent drainage pump breakdown, all the effluent of lagoon #3 had to be diverted into the conventional lagoon until July 1, by which time the liquid level had reached 44 inches (38,000 gallons). Loss by evaporation and seepage averaged 1,080 gallons per day in the following 16 days, after which it dropped to 980 gallons per day before the tomato pack, and to 800 gallons at the end of the study. For the most part, the liquid level stayed between 3 and 4 feet, leaving about 3 feet of freeboard with respect to the berm crests. An overflow was never established in this lagoon.

6.7.4 Analytical Results

Wastes were introduced into the consecutive lagoons #3 and #4 on roughly the same schedule. Because of the pump failure, BOD loadings during the pea pack had a higher average value than in the tomato pack, but during the latter they fluctuated more. Details of analytical and waste loading results are recorded in Tables 15-18 and 23, Appendix A.

6.7.5 Algae

The lagoon contents throughout all loading conditions of this study remained green with algae, becoming darker in colour after the tomato pack. (For algal determination see Table 27, Appendix A).

6.7.6 Uniformity

Mixing in the pond appeared to be incomplete, colour was uneven, no currents were evident, and samples taken from various points proved analytically different on occasion.

6.7.7 Dissolved Oxygen

Dissolved oxygen was present and generally rising throughout the study. However, during the first week when BOD loadings were excessive, the dissolved oxygen was depleted. In this same period septic odours were noted (July 3, 4, 6, 8, 15, 17). Later during normal operation, odour occurred on one day only, August 26th. The diurnal DO fluctuations appeared smaller than in the other lagoons (at least as determined from the 1 a.m. to 10 a.m. samples).

7. CALCULATIONS

7. CALCULATIONS

7.1 BOD-AIR RELATIONSHIP

Detailed calculations concerning the quantitative relationship between BOD and air supplied were computed as shown in the "A" series of Tables 3A to 18A, Appendix A. In such pond operations, a BOD removal relationship with respect to air supply is difficult to determine without a day-by-day evaluation of the lagoon activity, and hence these results were included for detailed observations. The results record the daily BOD composition of each lagoon in addition to providing representative average values for summarizing treatment parameters. See Summary Table 28, Appendix A.

7.2 LAGOON VOLUME AND SURFACE AREA

In the calculation, the volume and surface area parameters were evaluated from equations based on each lagoon's geometry.

Lagoon #	Volume Equation
1	$V = 2170h + 14.8h^2 + 0.0244h^3$
2	$V = 19,500 + 2110h + 14.7h^2 + 0.0244h^3$
3 (h = 0 to 84)	$V = 113h + 1.12h^2 + 0.00361h^3$
3 (h =84 to 96)	$V = 154h + 0.43h^2 + 0.00724h^3$
4	$V = 336h + 9.98h^2 + 0.0277h^3$

Lagoon #	Surface Area Equation
1	$A = 4180 + 57h + 0.1407h^2$
2	$A = 4064 + 56h + 0.1407h^2$
3 (h = 0 to 84)	$A = 217 + 4.33h + 0.0208h^2$
3 (h =84 to 96)	$A = 6830 + 4.33h + 0.0417h^2$
4	$A = 704 + 3.84h + 0.16h^2$

Where "h" is the basic water height in inches, "V" is in Imperial gallons and "A" is in square feet.

7.3 ESTIMATED VALUES

The calculations also contain a number of estimated values that are marked in the tables as bracketed figures. Sparing use was made of such estimated values, however they can be justified in improving data accuracy particularly in cases of important omissions in results. Omitted data when indicated by a blank, statistically assumes that the omitted values would coincide with averaged data; whereas, in most instances, superior estimates were available on the basis of other coincidental observations. In the case of missing BOD analyses, the COD and suspended solids analyses may be available for estimation of the missing BOD results.

7.4 BIO-REMOVED BOD

In determining the amount of BOD removed biologically (bio-removed BOD) each day, the following relationship was used:

Bio-removed BOD = Reduction in pond BOD + Influent BOD-effluent BOD

Calculation of ponded BOD quantities used "effluent" BOD concentrations assuming complete mixing occurred in the lagoon. By a number of test sampling trials performed, this assumption held very well for all lagoons except for #4, which exhibited some mild localized discrepancies. Influent BOD calculations assumed a steady 24-hour flow value for the observed waste input flow.

7.5 EFFLUENT BOD

For the calculation of "effluent" BOD, ground seepage and evaporation were combined with overflow effluent to estimate an "average volume loss" as the effluent flow. In these calculations, it was understood that evaporation was low compared to ground seepage while the latter flows were assumed to carry off BOD values comparable to an unfiltered overflow effluent. As bottom deposits did not accumulate to

a significant degree in the main lagoons, sludge could be assumed to be decomposing at rates comparable to any build-up. In addition, in the aspect of evaporation, many BOD producing materials are volatile, eg., hydrogen sulphide and acetic acid. "Average volume loss" and corresponding BOD values were averaged over week-long periods to reduce the errors induced by weather conditions upon liquid depth readings.

Lagoon #2 however had relatively insignificant seepage to introduce special effluent BOD calculations. During periods of loading, effluent flow equalled influent flow.

8. DISCUSSION OF RESULTS

8. DISCUSSION OF RESULTS

8.1 INTERPRETATION

The results of this lagoon test study proved unusually difficult to interpret for two main reasons:

Firstly, it was unfortunate for this study that the periods of available waste flow turned out to be so short and discontinuous. Reactions of lagoon treatment systems to loading effects, for example, are relatively slow compared to those of more compact treatment units. In addition, extra variables such as wind and sunshine may affect lagoon performance and often require additional time for evaluation as treatment parameters. A short operational period for a lagoon also fails to reveal whether or not lagoon bottom stabilization with respect to sludge deposition, soil permeability and ion exchange, etc., has actually occurred.

Secondly, the unreliability of the air distribution to lagoons #1 and #2 through the plastic hose aeration system created major problems for this study. In addition to requiring considerable maintenance and investigative attentions, lack of a steady air feed upset the scheduling and evaluation of maximum waste loading capacities for these ponds. The back pressures developed by clogging air tubing also resulted in a number of equipment breakdowns and consequent interruptions in air supply.

8.2 PERFORMANCES OF THE DIFFUSED AERATION LAGOONS

8.2.1 BOD Waste Loadings

For determination of BOD treatment capacities, the averaged long-term results in Table 28, Appendix A, appear to be the most reliable and therefore the best data. These results indicate that both lagoons #1 and #2 operated without odorous or anaerobic conditions during pea waste flow at more than 150 lb. BOD per acre per day despite shock loadings as high as 500 per cent of average value. Evidence for higher

treatment potentials is indicated by the 339 lb. BOD per acre per day operation of lagoon #1 during the tomato pack. While mild odours did occur on the 7th and 8th of Oct ~~September~~, the BOD loadings in the preceding six-day period had been quite high averaging 940 lb. BOD per acre per day. The pond required about three days for complete recovery after these heavy loadings ceased.

Similarly a parallel BOD loading of 980 lb. per acre per day for five days during the tomato pack brought lagoon #2 into an odorous state by the 5th of Oct ~~September~~. Continued loadings followed with highs of approximately 1,800 and 2,200 lb. BOD per acre per day on Oct ~~September~~ 8 and 9 respectively. With waste flow cut off, this lagoon also recovered in three days (ending on the 13th) with dissolved oxygen returning to 6.7 ppm. Mild odours from lagoon #2 were also present on the 17th and 18th of Oct ~~September~~ during relatively low loadings, the highest being 220 lb. per acre per day on the 17th. This circumstance could not be explained by any particular set of environmental factors.

The occurrences of low dissolved oxygen concentrations were also examined to determine their causes. Some lowered DO (dissolved oxygen) values appeared to result from shock loads of BOD such as in the above examples, and in isolated instances such as 654 lb. BOD per acre per day on June 24 (lagoon #1) or 678 lb. BOD per acre per day on August 28 (lagoon #2). Other instances were clearly influenced by biological turnovers in the ponds which often demonstrated recovery within a single day. On the 5th of July, an outstanding example occurred in lagoon #1 when a sharp drop of average dissolved oxygen occurred from 2.1 to 0.2 ppm under a very low BOD loading of 56 lb. per acre per day. Oxygen recovery to the 3.7 ppm level occurred by the next day under a 96 lb. per acre per day BOD loading. In fact recoveries from dissolved oxygen depletions had occurred during BOD loadings as high as 274 lb. per acre per day.

During the more conservative BOD loadings from 150 to 339 lb. BOD per acre per day, the averaged BOD concentrations of the lagoons remained within relatively narrow limits of 35 to 40 ppm for unfiltered samples. It was only at much higher loadings of 423 lb. per acre per day that pond BOD concentrations began to increase significantly up to 45 ppm.

8.2.2 Waste Loading Parameters

A comparison of the summaries for lagoons #1 and #2 failed to reveal any direct relationship between the amount of air supplied to the lagoons and the BOD removal efficiencies. For example, the pea pack operations loaded each lagoon almost equally, yet the percentage removal in lagoon #2 exceeded that of lagoon #1 (95.4%) by only an insignificant 1.1%, despite the fact that lagoon #2 was supplied with more than twice the amount of air. The only significant difference in these parallel operations was the higher average dissolved oxygen concentration in #2, 3.9 ppm as opposed to 2.9 ppm in lagoon #1. Indeed it can be noted that lagoon #2 tended to maintain higher dissolved oxygen values throughout the study except under severe overloading.

More than by any other factor, the quantity of removed BOD was determined by the amount of BOD added, although removal efficiencies for any pond tended to drop as loadings increased. For any particular rate of aeration it appeared that lowered oxygen levels merely signaled an increase in bacterial activity.

The influence of the 12-foot deep pit in lagoon #2 was difficult to evaluate from the data available. However, it was noted that lagoon #2 appeared generally more susceptible to odour production during low DO periods. It appeared to turn septic more often and much easier, a fact which suggests the possibility of anaerobic seeding from the more unstable regions. Certainly the presence of this pit did not demonstrate any benefits, particularly in light of the fact that lagoon #2 was more adequately aerated. After the equal loading during the pea pack, lagoon #2 averaged a slightly higher BOD concentration and a lower apparent BOD removal than lagoon #1 as if some stored BOD could be returning from such a pit. As in lagoon #3, which did accumulate sludge, the removal efficiency of #2 between packs appeared to be low.

Other parameters such as waste type, wind and sunshine, water temperature, and pH were considered, but the results were largely indeterminate. The possibility that tomato wastes may be easier to treat than pea wastes cannot be confirmed because of the widely different loadings applied in each case.

Dissolved oxygen concentrations however did appear to be easier to maintain in tomato wastes, both raw and in the lagoons. High water temperatures and pH's concurred having a common source in the clean-up wastes of the cannery. Statistically low DO occurrences accompanied periods of sudden pH and temperature increases.

Retention times in these lagoons could be only roughly estimated due to high seepage and evaporation rates not under operational control. Theoretically, retention periods varied widely from 8 to 140 days. Based on average effluent flow, including seepage and a minimum of evaporation, retention periods for lagoons #1 and #2 averaged 52 and 48 days respectively during the pea pack. Tomato pack operations corresponded to 22 and 19 days for the same two lagoons.

8.3 PERFORMANCE OF LAGOON #3

The behaviour of lagoon #3 in the studies resembled very much the action of an activated sludge plant with insufficient mixed liquor suspended solids. The aeration capacity of the unit exceeded the oxygen utilization rate by a wide margin and the lagoon contents were maintained at high dissolved oxygen levels. However, in common with dissolved oxygen results of the other lagoons, wastes in this lagoon during the pea pack were found to be difficult to maintain at high dissolved oxygen levels. During this pack, lagoon #3 averaged 3.2 ppm dissolved oxygen, while in other phases of the study including the tomato pack with its 300% higher BOD loadings, oxygen levels averaged above 6.5 ppm.

Lagoon #3 by the end of the study had actually accumulated about 18 inches of black bottom sludge largely derived from the heavier solids in the raw wastes. During the pea pack, the effluent of lagoon #3 averaged 344 ppm suspended solids as compared to 274 ppm in the raw waste feed. As the pond's retention period averaged less than 2.5 days, lagoon #3 was demonstrably a producer of sludge over this 38-day pack period. For the tomato pack period however, the suspended solids concentration was reduced from an average of 255 ppm to

213 ppm. Interpretation of these results must take into account that the tomato canning waste contained greater quantities of heavy solids such as tomato seeds, and that retention periods for the pea pack averaged longer than those for the tomato pack (1.5 days). The shorter retention time of the tomato wastes would reduce bacterial sludge development.

Generally speaking, activated sludge was not allowed to build up in lagoon #3 but was passed out the effluent. This insufficiency of sludge relative to waste and aeration feeds hampered the assessment of BOD removal. BOD removal was undoubtedly effected by three main processes; the settling out of heavy suspended solids, the production of sludge (conversion of soluble BOD materials to less active insoluble matter), and bacterial metabolism. As the amount of settled sludge and its relationship to BOD removals for each pack was indeterminate, actual biological BOD removals by lagoon #3 could not be computed. However, if the 34% removal of BOD during the tomato pack operations was assumed to be entirely attributable to a settling out of BOD-active suspended solids, then a minimum of 14.2 pounds of the 56 pound per day loading during the pea pack can be considered to have been biologically removed since an overall 59% BOD removal was effected. (Herein the agitator is assumed to control settling where pea wastes contain less heavier solids than tomato wastes). This 14.2 lb. of BOD removal is equivalent to 830 lb. per acre per day, a loading beyond apparent limitations of the other study lagoons.

The oxygenation rate of the fully immersed aerator at an estimated 0.96 brake horsepower (BHP) would be about 3.8 pounds of oxygen per hour (calculated from its rating of 4.0 pounds of oxygen per hour per BHP in tap water at 20°C). Suspended solids and elevated temperature would tend to decrease viscosity and hence relative power requirements. On the other hand, the effect of suspended solids and solutes in the wastes could more significantly reduce oxygen transfer rate coefficients.

8.4 PERFORMANCE OF LAGOON #4

Of the results of all the lagoons, the data obtained from the operation of lagoon #4 were considered to be the least reliable. This lagoon was greatly overloaded during the initial week of the pea pack and it required two weeks without loading to recover to completely aerobic conditions. This slow rate of recovery compared with the equivalent three day recovery period for lagoons #1 and #2 serves to illustrate the slow reactions of this lagoon for the purposes of this brief pilot plant study.

The lagoon was of a design not typical of stabilization ponds; the ratio of length to width was approximately 6:1. Mixing was less than ideal as the pond was small and always sheltered from wind by berms maintaining a three-foot freeboard above water level. The waste feed already partially treated was added at the top of one end of the pond. Patchy colorations and a number of analytical spot tests at different locations indicated that this pond was not always completely mixed as were the other lagoons.

The capacity of waste treatment in lagoon #4 appeared to be quite low. The average BOD loading of 72 lb. per acre per day during the tomato pack was reduced by only 47% with an expected effluent of 40 ppm BOD. After the tomato pack loading was cut off, the removed BOD averaged 15 lb. per acre per day. If the treatment efficiency were assumed to equal or exceed a 75% removal in this latter instance, then the stored BOD loading would effectively be equivalent to a feed of 15 to 20 lb. per acre per day. It would then appear that the seemingly small BOD removal of 2.75 lb. per acre per day during the "between pack" operations is misleading. Sludge accumulations from the pea pack overloading were apparently still being consumed, otherwise the removed BOD might have surpassed the small applied loadings by some 400%.

8.5 BIOLOGICAL POPULATIONS

As Tables 24 through 27 of Appendix A illustrate, a significant feature of the pilot lagoons was the dissimilarity of biological populations in the ponds. Up to the 5th of November, lagoon #4 demonstrated the highest density, an average of 37,500 algae per millilitre. This pond remained green coloured throughout all the waste loading studies with increases to the 200,000 per millilitre range noted after cessation of the tomato pack loadings. Protozoa content also averaged a high 3,200/ml during an abundant period spanning the month of September during the tomato pack.

Lagoons #1 and #2 averaged less algal growth with average counts of 27,100 and 28,800 per ml respectively. The algal growths of these ponds did not remain constant but fluctuated notably with lagoon loadings. Green, brown, grey, and blue tints imparted to the water in varying successions were considered to be largely due to changes in the algal population. Green, heavily-populated, chlorella-type algal growth was generally associated with low or no BOD loadings, while the other colorations of the water indicated algal deficiencies coincidental with high BOD waste loadings and consequently high suspended solids. Protozoa also appeared sporadically with concentrations averaging less than 2,000 per ml in the test samples.

Lagoon #3 was the least populated and affected by algal growths which here averaged only 5,000 per ml. The colour of this lagoon was determined generally by the colour of incoming wastes. In a sense, the algal population appeared to have biological competition in this lagoon from the abundant growths of the bacterium Sphaerotilus which even carried over into the effluent. The ratio of the average protozoa count of 3,000 per ml to the algae count is much higher than the ratios for the other lagoons. On a number of occasions, the protozoa were actually denser than the algae.

The tabled results detailing individual sample analyses were notable in the frequency and variety of the changes in the dominant algal species. It would seem from this that the various algal populations were in a continuous state of flux as expansion and die-off of successive species occurred.

Observations made of the lagoons themselves would tend to reinforce this concept since many changes (particularly in lagoons #1 and #2) could be observed to occur in a matter of hours. The detailed tables of BOD calculations in Appendix A demonstrate a daily rise-and-fall of BOD content for each of the lagoons. These BOD fluctuations prove to be surprisingly independent of influent BOD and may be related only in a very complex way to corresponding COD (chemical oxygen demand), DO (dissolved oxygen) and weather fluctuations.

Algal populations at least in lagoons #1 and #2 have no discernible relationship with the quantity of air supplied. The additional air supplied to lagoon #2 in the studies had negligible effects on algal development. On the other hand, increased BOD loading had a strong influence. Such loadings quickly decreased algal population to very low levels and a rapid regrowth would occur only after loadings had diminished. During extended periods of no loading, chlorella - type algae tended to dominate the environment even in lagoon #3.

8.6 NUTRIENT CONDITIONS

Table 29, Appendix A, summarizes the nutrient conditions of raw wastes and lagoon contents. This table lacks the values for nitrite and nitrate nitrogen but the concentrations of these tended to be insignificantly small on an average basis. The data based on weekly sampling (except in the case of pH and BOD) indicate only general lagoon conditions and cannot represent a full nutrient study.

Notably the accepted concentrations of nutrient phosphate necessary for efficient biological treatment were exceeded probably due to the addition of cleaning wastes from the cannery. A 1:28 ratio for pea wastes and a 1:39 ratio for tomato wastes exceeded the necessary phosphate:5-day BOD ratio of 1:100. Nitrogen availability on the other hand proved to be more critical; the desirable nitrogen:BOD ratio of 1:20 was not attained either in the pea wastes (1:23) or in the tomato wastes (1:39).

The most notable trend brought to light by Table 29 was the development of high nitrogen values within lagoon #3, particularly during the pea pack. While the evidence is not conclusive, indications are that nitrogen-fixing organisms were active in this pond. This lagoon developed a 46.8 ppm nitrogen content from a waste averaging only 26.7 ppm. The higher nitrogen concentration carried over into lagoon #4 during the pea pack, there remaining as high as 26.8 ppm. Lagoons #3 and #4 maintained their higher nitrogen concentrations right through the "between pack" period. None of this additional nitrogen can be attributed to an increase in ammonia content; neither is it apparent by analytical evidence nor likely in light of the cannery's operation, that an unsampled waste of higher nitrogen content could have caused these singular effects. Even through the tomato pack, lagoon #3 preserved its nitrogen concentrations while BOD was being significantly reduced. By the end of the study, lagoon #4 also showed a relatively high nitrogen content as if this ability had been passed along.

In view of the nature of the waste being treated, the conditions for nitrogen fixation in lagoon #3 appeared very good. The phosphate content was high as required (14), and the aerator efficiently provided atmospheric nitrogen for the purpose. Moreover lagoon #3 with a short retention (in the order of three days) had the best opportunity to develop significant concentrations of the legume waste in particular. Legume plant materials such as would be present in pea wastes are notably efficient in sponsoring the growth of numerous nitrogen-fixing bacterial species of the Rhizobiaceae family. Sphaerotilus has been suspected of being a nitrogen-fixing organism (15).

Phosphate removals were also noted in the lagoons, lagoon #3 being the least efficient in this respect (little more than 20% removal). Lagoons #1 and #2 removed in the order of 80% of the phosphate. The conventional lagoon averaged 50% removal. The main mechanism of removal might be considered to be high pH precipitation, promoted by algal utilization of carbon dioxide. In addition soluble polyphosphate compounds may be utilized by pond biota and converted to orthophosphate ions which more readily precipitate out of solution in the presence of other ions such as calcium or iron. However these arguments are not conclusive by any means for pH and phosphate concentration in the pond bear no distinguishable relationship.

In the raw waste feed, BOD tended to be associated with dissolved volatile solids; however, in the treatment lagoons BOD corresponded more closely to the suspended volatile solids with some exception following tomato pack loadings. Total dissolved solids (not tabulated directly) tended to rise throughout. Most of this rise was attributable to non-volatile solids derived from the higher salt content of the raw wastes and in part to some evaporation. Inorganic salt balances showed considerable net losses of soluble materials in the pond systems.

8.7 GENERAL IMPLICATIONS OF THE STUDY

From the evidence of lagoons #1, #2 and #4, the aerated lagoons showed at least a 10 to 15-fold superiority over conventional stabilization ponds in terms of BOD loading capacities per acre. Nevertheless, this increased capability did not appear to be a direct function of the aeration capacity even when the additional aeration had provided a higher dissolved oxygen content. For this reason, it must be assumed that increased water circulation in the pond was a major factor in improving the aerobic efficiency of lagoon treatment. This assumption cannot be overlooked particularly in view of the fact that the main criterion of limiting BOD loadings is actually the maintenance of an odourless treatment performance.

Anaerobic bacteria as the source and cause of fermentation odours would be adversely affected by mixing in a dominantly aerobic pond. A periodic exposure to sunlight and surface oxygen has a synergistic "disinfection" action toward these organisms. Thus even when oxygen levels drop to zero temporarily, active anaerobic organisms would not be present in the water media to take immediate advantage of the environment. The easier susceptibility of lagoon #2 toward odour production (relative to lagoon #1) may be attributable to the uncirculated water volume provided in the additional deep pit section in this lagoon's bottom. While it cannot be considered that this bottom pit operated anaerobically at all times, it could be considered to be its weakest region for avoiding anaerobic activity.

In addition mixing action would be reasoned to improve the diffusion rates of food, oxygen, and micro-nutrients into the bacterial and algal cells acting on the wastes. Through such mixing, the development of increased bacteria suspensions in the media would serve to increase the quantity of active biomass removing the organic substrate. For example, the simultaneous presence of high dissolved oxygen and BOD levels in lagoon #3 suggested the lack of sufficient bacterial mass to use up the oxygen tension supplied. The higher dissolved oxygen content of lagoon #2 during loadings comparable to lagoon #1 may also indicate this general deficiency.

For algal photosynthetic activity as well, mixing may be advantageous. References (16) and (17) indicated that a higher radiation efficiency may well be achieved by green plants subject to intermittent light radiation as compared to those under steady illumination. Vertical lagoon mixing could result in higher sunlight utilization by cycling algal cells.

Comparison of the aeration devices was possible in this study. The mechanical aerator was highly regarded in its trouble-free operation with only the occasional development of foaming difficulty. The sludge produced by this aerator moreover had poor settling characteristics. On the other hand, the performance of the aeration hose distribution system for the first two lagoons was disappointing in the rapid clogging properties which this hose showed. As noted in Appendix B, very minute quantities of scale material developed in the air valves (slits) along this tubing within two to three weeks. Evaporation of liquid at the pore water-air interfaces was believed to have caused precipitation from a calcium carbonate saturated water. Other saturated salts in the water containing iron and phosphates also co-precipitated with this material. The scale material however was found to be very soluble in hydrochloric acid. Even the fumes of this acid was found to dissolve the scale, and for this reason, the use of such plastic aeration hose was not regarded as impractical if employed with a suitable acid injection device for periodic hose cleaning (18). A longer period for lagoon bottom stabilization and a larger size lagoon should help minimize the development of various salt saturations within such ponds and result in a lessening of the clogging

effect. It seemed likely that other hose characteristics could also be improved.

A mention might be made concerning the relatively large BOD, COD, DO, and suspended solids fluctuations noted in the tabulated results of Appendix A. In many ways the sudden shifts in analytical findings appear to be interrelated and effected by the biological populations within the pond. However closer monitoring of algae and micro-organism populations was not possible for this study but could provide a fruitful study in future investigations. Also not possible in the brief study period available was the correlation of the results with weather conditions. Seepage and evaporation rates were not determinable as separate parameters.

9. CONCLUSIONS

From these pilot lagoon studies at Chatham, the following conclusions were deemed significant:

1) The diffused aeration lagoons (#1 and #2) in the study operated aerobically at overall loadings up to 350 pounds of 5-day BOD per acre per day. The prospects of treatment potentials beyond this loading, being developed in future designs, look very good. However, for single stage (one lagoon) treatment, effluent values may range around 40 ppm 5-day BOD (unfiltered) with over 75% removals being effected.

2) A lack of a bacterially active sludge and evidence of solids deposition in lagoon #3 obscured much of the true potential value of the mechanical aerator. It was estimated that this lagoon biologically removed a minimum of 830 pounds of BOD per acre per day during a retention period of about two days.

3) Aerated lagoons are relatively stable toward shock loadings. Shock loadings such as 500% normal loading for one day or 300% for a four-day period would appear to be within the lagoons' capabilities.

4) Required air supply was not conclusively determined during the study but did not appear to be an exact limiting criterion in lagoon design. The lagoon #1 aeration hose layout combined with the manufacturer's rating of 1-2 cfm per 100 feet of tubing would appear suitable pending further investigations of this parameter.

5) Lagoon mixing or circulation,particularly in the vertical direction, appeared to be an important factor in improving performance capacities of aerated lagoons. BOD removal may not depend directly upon air supplied by the hose so much as upon how much suitable circulation the air additions can stimulate.

6) The disadvantage of air slit clogging must be overcome however before this method becomes practical for general use. With suitably inert distribution lines, hydrochloric acid fumes can remove clogging scale. (See Appendix B for details). Improved hose design and stabilization of the lagoon bottom with respect to calcium and other hardness ions may also prove beneficial.

7) The presence of anaerobic basins or any uncirculated waste volume in an aerated lagoon would appear to be unnecessary for efficient operation. Fluctuations in lagoon dissolved oxygen values should be expected to approach zero on occasions through biological action; therefore numerous colonies of anaerobic organisms should not be spawned in stagnant basins for the accelerated souring of the entire waste volume during such periods.

8) Diffused aeration lagoons with an 80% retention proved superior at phosphate removal.

9) The aeration and mixing conditions set up by the mechanical aerator in lagoon #3 stimulated waste removal by the growth of Sphaerotilus natans. This growth removed BOD but did not settle well (19 & 15).

10) Nitrogen-fixing organisms appeared active in lagoon #3 particularly during operations involving pea pack wastes.

11) Raw pea wastes from the cannery were unusually erratic in flow due to harvesting difficulties in 1963. The values of 400-600 ppm BOD and 200-300 ppm suspended solids were below those cited in the literature. A slight nitrogen deficiency (1:23 nitrogen/BOD ratio) in this waste was its main defect with respect to efficient BOD treatment.

12) Tomato wastes were also less concentrated containing 450-550 ppm average BOD and 250-350 ppm suspended solids. A nitrogen deficiency was present in this waste (1:39 nitrogen/BOD ratio). Tomato seeds in the waste were an undesirable component for treatment in lagoons.

10. RECOMMENDATIONS

1) The study and design of aerated lagoons should concentrate on the more promising potentials of the shallow, completely mixed lagoon resembling lagoon #1 in this study.

2) The reliability of the diffused air distribution system must be improved upon before incorporation in any future design. Without an effective scale-removal system and layout, a complete reexamination of aeration devices should be considered.

3) Pretreatment such as screening is recommended particularly for tomato wastes when it may settle out seeds in the form of sludge banks. For inclined screens, 20 mesh would appear optimum, but vibrating screens as high as 38 mesh may be useful in reducing lagoon waste loadings.

4) Further consideration might be made of the advantages of the mechanically aerated lagoon as a first stage in lagoon treatment to reduce lagoon area requirements or to increase future capacities. The additional nitrogen from atmospheric fixation would probably serve to assist removal of phosphate materials where the latter is in abundance relative to other nutrients.

5) Direct nitrogen addition as nutrient to the diffused air lagoons might be considered in the quest for higher BOD and phosphate removals.

6) Future lagoon studies might attempt to examine the intrinsic effects of improved circulation upon performance as divorced from the parameter of increased aeration.

7) Further investigations should examine the relationship of algal and bacterial populations to the fluctuating analytic results for fruitful information concerning the biology of lagoon waste treatment.

11. ACKNOWLEDGEMENTS

In any prolonged study, such as this one which was undertaken at Chatham, the worthy contributions of many individuals and firms are involved. The consulting engineer, Mr. William Case of Todgham and Case, was subjected to many of the problems associated with the study. Being in Chatham, he was called upon by Commission staff on many occasions for advice and for assistance in resolving the problems. These contributions of Mr. Case and his staff were greatly appreciated.

The laboratory was established at the Chatham Waterworks and this required considerable sacrifice on the part of Mr. E. O'Mara and his waterworks staff. Their whole laboratory was at the Commission's disposal and their overall cooperation and their gracious welcome at all times is gratefully acknowledged.

This project could not have been carried out without the generous use of equipment on behalf of many suppliers. The surface aerator used in the study was made available by Simon-Carves of Canada, Limited, Toronto. The aeration tubing was supplied by Hinde Engineering Company, Chicago, who provided the tubing at a discount. The natural gas meters used for metering the air were made available and calibrated by the Union Gas Company, Chatham. The Works Department for the City of Chatham were helpful in allowing use of the compressor on many occasions for the purpose of cleaning the air lines. The Chatham Waterworks also permitted the borrowing of tools, equipment, and chemicals from time to time. Their availability greatly facilitated procedures.

There are many others too numerous to mention who provided assistance throughout the study, and at this time sincere appreciation for their aid is offered.

12. REFERENCES

1. Sanborn, N. H., "Treatment of Cannery Wastes", Sewage Works Eng., 20, 199 (1949)

2. Southgate, B. A., "Treatment and Disposal of Industrial Wastes", Her Majesty's Stationery Office, London (1950).

3. Clinton, M. O., "Seymour Solves Unusually Difficult Waste Treatment Problem", Water and Sewage Works, 102, 11, 438 (1955)

4. Eckenfelder, W. W., "Pilot Plant Investigations of Biological Sludge Treatment of Cannery and Related Wastes", Proc. 7th Purdue Conference 181 (1952)

5. Templeton, C. W., "Cannery Waste Disposal and Treatment", Sew. and Ind. Wastes, 23, 12, 1540 (1951)

6. DuByne, F. T., "Development of a Spray Irrigation Disposal Program for Food Processing Plants" - A case history, Campbell Soup Co., Napoleon Ohio Plant, June 20, 1962.

7. Nemerow, N. L., "Theories and Practices of Industrial Waste Treatment", Addison-Wesley Publishing Co., Reading, Mass., (1963)

8. Eckenfelder, W. W. and O'Connor, D. J., "Treatment of Cannery Wastes in an Aerated Lagoon". A report conducted by Civil Engineering Dept., Manhattan College, N.Y., November, 1958.

9. Anderson, J. B., and Zweig, H.P., "Biology of Waste Stabilization Ponds", Southwest Water Works Journal, May 1962.

10. McKinney, R. E. and Edde, H., "Aerated Lagoon for Suburban Sewage Disposal", Jour. WPCF, 33, 12, 1277 (1961)

11. Meyer, O. L., "Aeration System", Pub. Works, 93, 8, 79, (1962)

12. Hurwitz, E., "Conversion to an Aerated Lagoon Extends Pond's Life", Water and Sewage Works, 110, 10, 359 (1963)

13. Guillaume, F., "Tests on Simcar Aerator", Private correspondence, 1962

14. Sawyer, C. N. and Ferullo, A.F., "Nitrogen Fixation in Natural Waters Under Controlled Laboratory Conditions". U.S.P.H.S. Publication No. S.E.C. TR W-61-3 Page 100.

15. Pipes, W.O. and Jones, P. H., "Decomposition of Organic Wastes by Sphaerotilus" Biotech. and Bioeng. Vol. 5, 287-307 (1963)

16. Arnon, D. I., "Conversion of Light into Chemical Energy in Photosynthesis" Vol. 184, July 4, 1959

17. Arnon, D. I., "The role of Light in Photosynthesis" Scientific American, Vol. 203, 5, Nov. 1960

18. Wells, W. N., "Diffuser Tube Clogging" Jour. WPCF 32, 8, 895 (1960)

19. Donders, N. C. "Sphaerotilus, Its Nature and Economic Significance", Adv. in Applied Microbiology Vol. 3, 77-107 (1961)

13. APPENDIX A

Tables

Tables

Tables

Tables

APPENDIX A

TABLE I

RESULTS OF ANALYSES OF PEA PROCESSING WASTES

DATE 1963	TEMP. °C	PH	BOD PPM	COD PPM	COD/BOD	SOLIDS PPM TOTAL	DISS.	SUSP.	DO PPM
June 21	24	7.8	1935	3078	1.6	3349	2808	541	5.2
24	32	7.1	2620	4010	1.5	4373	2938	1435	1.2
24	30	6.9	1700	3239	1.9	2815	2025	790	1.4
24	28	5.3	2000	2969	1.5	2913	2067	846	1.1
25	26	7.4	900	1195	1.3	1395	1116	279	2.4
25	26.5	6.7	544	588	1.1	774	704	70	4.1
25	26	7.2	940	877	0.9	944	822	122	2.0
26	23	7.3	780	998	1.3	1191	992	199	7.1
26	26.5	7.6	548	906	1.7	1053	895	158	3.9
26	25	7.0	588	906	1.5	1076	886	190	2.4
27	24	7.1	560	841	1.5	1189	880	309	3.8
28	25	7.5	344	615	1.8	1157	690	467	5.8
29	27	7.0	712	1070	1.5	1278	945	333	0.6
30	28	7.1	760	944	1.2	1134	827	307	1.0
July 1	27	7.5	304	737	2.4	943	706	237	0.7
2	28	6.8	380	790	2.1	1308	738	570	1.1
3	28	6.7	340	716	2.1	843	595	248	0.8
4	29	6.6	240	755	3.1	897	439	458	1.0
5	27	7.1	-	758	-	722	580	142	0.6
6	23	9.8	756	-	-	755	565	190	0.8
7	-	-	-	-	-	-	-	-	-
8	25	7.6	181	237	1.3	513	438	75	1.1
9	22	7.1	240	282	1.2	685	501	184	0.6
10	23.5	7.4	982	1170	1.2	1147	885	262	1.7

DATE 1963	TEMP.	PH	BOD PPM	COD PPM	COD / BOD	SOLIDS PPM TOTAL	SOLIDS PPM DISS.	SOLIDS PPM SUSP.	DO PPM
July 11	21	7.7	220	224	1.0	786	618	168	0.5
12	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-
14	22	8.0	281	588	2.1	2290	2172	118	2.0
15	-	7.5	430	226	0.5	760	549	211	3.3
16	23	7.0	930	1400	1.5	2190	1954	236	1.1
17	22	7.6	-	124	-	1542	1099	443	1.1
18	22	7.6	148	153	1.0	1538	1097	441	1.8
19	23	7.8	74	163	2.2	402	395	7	1.5
20	23	7.8	288	357	1.3	858	635	223	2.0
21	26	7.5	424	434	1.0	1006	882	124	1.5
22	23	-	-	287	-	825	769	56	0.5
23	22	-	108	153	1.4	465	395	69	1.1
24	24	7.6	466	965	2.1	1357	1136	221	1.6
25	26	7.0	-	-	-	744	568	176	0.8
26	25	7.1	501	800	1.6	1644	1436	208	1.7
27	29	6.7	444	746	1.7	827	534	293	0.8
28	28	7.8	239	428	1.8	603	523	83	1.1
29	27	7.2	312	467	1.5	1069	986	80	1.1
30	26	7.4	408	728	1.8	2190	1194	996	1.8
31*	22	6.9	152	284	1.9	1223	924	299	1.4

* GRAB SAMPLE ONLY

UNMARKED SAMPLES ARE 12-HOUR HOURLY COMPOSITES BETWEEN MID-NIGHT AND 12 O'CLOCK NOON

APPENDIX A

TABLE 2

RESULTS OF ANALYSES OF TOMATO PROCESSING WASTES

DATE 1963	TEMP. C	PH	BOD PPM	COD PPM	COD/BOD	SOLIDS PPM TOTAL	DISS.	SUSP.	DO PPM
Aug 15*	25	7.7	508	1080	2.1	1183	891	292	1.2
21	24	7.9	124	378	3.1	530	509	21	5.3
27	28	10.2	206	575	2.8	897	782	115	10.0
28	27	7.5	544	930	1.7	1495	1147	348	4.8
29	28	7.0	668	1085	1.6	1493	1244	249	6.2
30	28	8.8	640	976	1.5	1742	1111	631	5.7
31	26	11.2	652	940	1.4	1190	1005	185	6.9
Sept. 1	-	-	-	-	-	-	-	-	-
2	23	9.0	-	236	-	650	633	17	7.2
3	24	8.3	164	171	1.2	755	669	86	6.9
4	27	7.8	-	465	-	903	627	276	5.2
5	26	8.3	244	303	1.2	772	663	109	6.1
6	25	7.7	480	492	1.0	1022	789	233	4.7
7	26	8.8	228	540	2.4	1223	534	689	7.2
8	27	8.4	228	210	0.9	897	732	165	7.4
9	25	8.5	127	218	1.7	1366	1110	256	8.1
10	26	9.6	257	835	3.1	1529	1151	378	7.0
11	27	12.2	148	575	3.9	1297	1079	218	7.0
12	26	7.9	220	617	2.8	763	563	200	7.9
13	25	8.2	-	218	-	1042	649	393	8.1
14	26	8.3	144	190	1.3	1960	1822	138	7.1
15	26	7.8	206	695	3.4	2303	1950	353	6.0
16	25	8.1	127	192	1.6	826	853	-	6.7

DATE 1963	TEMP. C	PH	BOD PPM	COD PPM	COD/BOD	SOLIDS PPM TOTAL	DISS.	SUSP.	DO PPM
Sept.17	22	8.7	305	509	1.7	1041	775	266	6.9
18	23	8.3	-	-	-	-	-	-	7.0
19	-	-	-	-	-	-	-	-	-
20	25	8.1	357	726	2.0	1256	1070	186	8.4
21	23	8.5	225	313	1.4	947	795	152	8.0
22*	-	-	147	230	1.6	662	566	96	-
23	24	-	206	473	2.3	723	609	114	8.7
24	22	-	238	543	2.3	873	787	86	8.2
25	23	-	125	240	1.9	831	738	93	7.6
26	21	-	350	524	1.5	1237	953	284	8.2
27	22	7.8	258	631	2.5	1557	1358	199	7.2
28	23	7.5	564	835	1.5	1228	1061	167	7.5
29	21	7.7	172	346	2.0	1594	1251	343	7.5
30	22	8.3	822	1025	1.3	1621	1502	119	8.7
Oct. 1	23	7.8	490	685	1.4	1403	1273	130	7.3
2	21	8.1	468	551	1.2	882	771	111	7.2
3	22	8.5	1184	1240	1.1	1563	1383	180	3.9
4*	24	10.0	448	518	1.2	1243	921	322	6.7
4	-	-	508	-	-	2285	1403	882	-
5	23	8.5	496	651	1.3	1122	848	274	6.0
6	-	-	-	-	-	-	-	-	-
7	22	7.7	600	792	1.3	1410	1202	208	8.4
8	21	8.9	1060	1670	1.6	1576	1233	343	7.0
8*	-	-	1024	-	-	3060	1804	1256	-
8*	-	-	318	-	-	928	566	362	-
8*	-	-	265	-	-	750	538	212	-

DATE 1963	TEMP. C	PH	BOD PPM	COD PPM	COD / BOD	SOLIDS PPM TOTAL	DISS.	SUSP.	DO PPM
Oct. 9	19	6.9	1312	1390	1.1	1463	1194	269	7.2
10*	-	-	568	527	0.9	1333	715	618	-
11*	-	-	900	1370	1.5	1834	1468	366	-
12	21	7.8	640	692	1.1	1013	619	394	4.2
12*	-	-	548	-	-	3556	512	3044	-
12*	-	-	1064	-	-	1556	1034	522	-
13	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-
15	21	7.0	536	532	1.0	989	854	135	7.8
15*	-	-	1372	-	-	1548	1238	310	-
15*	-	-	1212	-	-	2480	2092	388	-
16	20	9.8	1460	1570	1.1	1861	1455	406	6.8
16*	-	-	1332	-	-	2050	1542	508	-
16*	-	-	1700	-	-	2740	1870	870	-
17	18	7.9	140	226	1.6	901	812	89	10.0
18	15	7.7	580	916	1.6	2767	1378	389	7.5
19	16	7.8	-	-	-	-	-	-	10.0

* GRAB SAMPLE ONLY

UNMARKED SAMPLES ARE 12-HOUR HOURLY COMPOSITES BETWEEN MID-NIGHT AND 12 O'CLOCK NOON

APPENDIX A

TABLE 3

RESULTS OF AERATED LAGOON #1 DURING PEA PACK

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
June 24	2107	35	-	98	-	1024	7	99.5	3406	65	97.1	3.5	106	424	23	1.6	7.7	7.5	10.7
25	795	58	-	92.7	-	157	43	72.6	887	93	89.5	3.5	40	160	24	0.7	0	7.3	10.7
26	638	33	-	95	-	182	65	64.4	937	77	92	3.5	32	128	26	2.6	2.4	7.5	10.5
27	560	28	-	95	-	309	146	52.8	841	122	85.5	3.5	28	112	26	1.2	1.7	7.7	10.8
28	344	14	-	96	-	467	43	91	615	134	78.2	6.0	31	124	26	3.2	7.2	7.8	10.7
29	712	28	-	96	-	333	21	93.8	1070	119	88.9	6.0	63	252	27	3.2	5.0	7.7	9.5
30	760	21	-	97.2	-	307	54	82.5	944	133	86	4.9	54	216	27	3.0	3.5	7.5	8.3
July 1	304	25	-	92	-	237	61	74.4	937	142	80.8	4.9	21	84	27	2.2	2.2	7.6	7.4
2	380	42	-	89	-	570	108	81.1	790	145	81.6	3	16	64	29	1.6	-	7.6	7.4
3	340	32	-	90.6	-	248	33	86.8	716	148	79.5	3	14	56	25	0.9	4.2	7.6	9.8
4	240	53	-	78	-	458	33	92.7	755	156	79.4	3	10	40	26	0.6	3.5	7.4	9.8
5	-	12	-	-	-	142	146	0	758	125	83.5	5	-	-	24	0.2	-	7.4	7.8
6	756	90	-	88.1	-	190	208	0	-	156	-	5	53	212	25	3.6	3.8	7.5	2.4
7	-	50	32	-	-	-	91	-	-	266	-	0	0	0	25	4.6	4.3	7.4	-
8	181	10	20	94.5	89	75	34	54.7	237	143	39.7	5	11	44	24	3.0	1.6	7.5	-
9	240	-	32	-	87	184	109	40.7	282	251	11	5	17	68	22	2.0	1.2	7.5	-
10	982	57	49	94.4	95	262	16	94	1170	135	88.5	10	140	560	21	2.3	3.2	7.5	4.3
11	220	46	52	79	76.5	168	99	41.1	224	266	0	10	33	132	21	0.3	0.6	7.5	4.3
12	-	34	24	-	-	-	85	-	-	130	-	0	0	0	22	1.0	2.0	7.5	2.7
13	-	47	27	-	-	-	107	-	-	142	-	0	0	0	24	4.0	4.6	7.6	1.6
14	281	34	15	87.9	95	118	50	57.6	588	129	78	5	18	72	23	5.3	3.6	7.6	2.8

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
July 15	430	42	28	90.3	94	211	49	76.8	226	121	46.5	5	30	120	21	2.6	3.3	7.7	2.8
16	930	33	20	96.5	98	236	46	80.5	1400	137	90.4	5	64	256	22	5.4	5.0	7.8	2.8
17	-	-	31	-	-	443	58	87	124	143	0	5	-	-	23	0.5	1.7	7.5	2.4
18	148	11	11	92.6	93	441	58	86.9	153	109	28.8	5	11	44	24	3.2	6.4	7.7	2.4
19	74	18	18	75.8	75.8	7	28	0	163	136	16.6	5	5	20	25	5.3	4.5	7.7	7.7
20	288	31	25	89.3	91	223	21	90.5	357	109	69.5	5	19	76	25	4.4	2.9	7.7	8.0
21	424	48	39	88.8	91	124	40	67.8	434	152	65	5	30	120	22	2.6	4.5	7.7	7.1
22	-	45	69	-	-	56	-	-	287	96	66.6	5	-	-	24	2.2	1.7	7.7	7.1
23	108	77	21	28.7	81	69	150	0	153	272	0	5	9	36	24	1.3	2.4	-	0
24	466	30	31	93.5	94	221	147	33.5	965	125	87	5	33	132	25	3.0	2.4	7.6	3.4
25	-	27	21	-	-	176	176	0	-	133	-	0	0	0	25	2.6	3.0	7.6	2.5
26	501	35	24	93	95	208	207	0	800	124	84.5	4	29	116	26	3.5	3.5	7.6	2.5
27	444	32	26	92.8	94	293	118	59.8	746	113	85	4	27	108	27	2.4	3.8	7.7	0.5
28	239	13	11	94.6	94.6	80	115	0	428	218	49	4	14	56	27	2.9	4.5	7.7	0.5
29	312	38	31	87.9	87.9	183	112	0	467	97	79.2	4	20	80	27	3.9	1.6	7.7	0.5
30	408	29	30	81.5	81.5	996	366	63.3	728	115	84.2	4	25	100	26	1.9	1.8	7.5	0.5
31	152	29	27	81	81	299	113	63.2	284	123	56.6	4	8	32	25	-	2.5	7.6	0.4

TABLE 3A

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #1 - PEA PACK PERFORMANCE

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 CONC.-PPM	REMARKS
June 24	45	129,000	7,020	2,107	35	45.1	106	0.286	75.3	15,400	4.7	
25	45¼	130,000	7,040	795	58	75.5	40	"	71.0	15,400	0.4	
26	46½	134,000	7,130	638	33	44.2	32	"	36.1	15,100	2.5	AVERAGE VOLUME LOSS
27	48½	142,000	7,250	560	28	39.8	28	"	46.8	15,500	1.5	922 GALLONS/DAY
28	50	148,000	7,380	344	14	20.7	31	"	8.5	15,400	5.2	
29	51½	153,000	7,480	712	28	42.9	63	"	72.8	13,700	4.1	
30	52	156,000	7,520	760	21	32.8	54	"	46.5	13,000	3.3	
July 1	53	160,000	7,590	304	25	40.0	21	0.52	-9.6	10,700	2.2	
2	55	167,000	7,730	380	42	70.1	16	"	32.2	10,700	1.6	
3	55	167,000	7,730	340	32	53.4	14	"	-21.6	14,100	2.7	AVERAGE VOLUME LOSS
4	55	167,000	7,730	240	53	88.5	10	"	78.0	14,100	2.1	1,200 GALLONS/DAY
5	55	167,000	7,730	(240)	12	20.0	(17)	"	(-127.3)	11,100	0.2	
6	58½	182,000	7,990	756	90	163.8	53	"	121.8	3,460	3.7	
7	60	182,000	8,100	-	50	94.5	0	"	75.5	0	4.5	
8	59	185,000	8,030	181	10	18.5	11	1.81	(-33.0)	0	2.3	
9	60½	191,000	8,140	240	-	-	17	"	(-33.0)	0	1.6	
10	60½	191,000	8,140	982	57	108.8	140	"	157.4	6,200	2.8	AVERAGE VOLUME LOSS
11	61½	195,000	8,210	220	46	89.6	33	"	53.8	6,200	0.5	4,760 GALLONS/DAY
12	62	197,000	8,250	-	34	67.0	0	"	-27.4	3,390	1.5	
13	62	197,000	8,250	-	47	92.6	0	"	23.1	2,300	4.3	
14	62½	199,000	8,290	281	34	67.7	18	"	3.3	4,030	4.5	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL.	AIR SUPPLY CU.FT.	DISS.O_2 CONC.-PPM	REMARKS
July 15	61	192,000	8,170	430	42	80.6	30	1.89	43.7	4,030	3.0	
16	62	197,000	8,250	930	33	65.0	64	"	(+54.8)	4,030	5.2	
17	63	201,000	8,320	(90)	-	-	6.5	"	(+54.8)	3,450	1.1	AVERAGE VOLUME LOSS
18	63	201,000	8,320	148	11	22.1	11	"	-5.0	3,450	4.8	6,200 GALLONS/DAY
19	63	201,000	8,320	78	18	36.2	5	"	-23.7	11,100	4.9	
20	63½	203,000	8,360	288	31	63.0	19	"	-18.8	11,500	3.7	
21	64	206,000	8,400	424	48	98.9	30	"	32.5	4,900	3.6	
22	65	210,000	8,480	(150)	45	94.5	(11)	1.91	(-58.4)	(10,220)	2.0	
23	65	210,000	8,480	108	77	162.0	9	"	106	0	1.9	
24	65	210,000	8,480	466	30	63.0	33	"	37.4	4,900	2.7	AVERAGE VOLUME LOSS
25	65	210,000	8,480	-	27	56.7	0	"	(-18.7)	4,250	2.8	4,900 GALLONS/DAY
26	65	210,000	8,480	501	35	73.5	29	"	33.4	3,600	3.5	
27	65	210,000	8,480	444	32	67.2	27	"	64.7	720	3.1	
28	65½	212,000	8,520	239	13	27.6	14	"	-40.9	720	3.7	
29	65½	212,000	8,520	312	38	80.6	20	1.54	36.7	720	2.8	AVERAGE VOLUME LOSS
30	66	215,000	8,560	408	29	62.4	25	"	23.5	576	1.9	4,760 GALLONS/DAY
31	66	215,000	8,560	152	29	62.4	8	"			2.5	
TOTALS										314,966		
AVERAGE	59½	186,000	8,050	379	35.8	66.4	27.5	1.30	26.3	8,290	2.87	

APPENDIX A

TABLE 4

RESULTS OF AERATED LAGOON #1 BETWEEN PEA AND TOMATO PACKS

DATE 1963	BOD UNFILT PPM	BOD FILT PPM	COD PPM	SUSP. SOLIDS PPM	TEMP °C	PH	DO DAY PPM	AIR RATE CFM
Aug 1	21	20	120	195	24	7.7	3.8	0.3
2	17	16	104	188	24	7.7	3.5	0.3
3	-	-	-	-	-	-	-	0.3
4	-	-	-	-	-	-	-	0.3
5	17	14	90	67	22	7.8	3.8	0.3
6	17	16	90	65	25	8.0	6.8	0.3
7	24	10	82	62	25	8.0	6.5	-
8	14	13	90	52	24	8.0	6.6	8.0
9	14	14	77	75	24	8.0	6.1	6.6
10	-	-	-	-	23	8.1	7.2	4.8
11	-	-	-	-	23	8.1	7.7	3.5
12	16	9	81	52	23	8.0	7.7	2.2
13	12	-	85	52	22	8.4	7.7	1.9
14	16	-	88	49	20	8.5	8.0	1.1
15	17	10	88	-	20	8.3	7.5	0.7
16	32	23	102	49	20	8.8	8.1	0.5
17	-	-	-	-	20	-	-	0.5
18	-	-	-	-	-	-	-	0.5
19	18	11	77	36	20	8.5	8.3	0.4
20	33	29	76	69	20	8.6	8.0	0.4
21	13	13	73	63	20	8.6	8.7	7.0
22	13	7	81	46	24	8.5	6.7	-
23	13	10	79	41	23	8.4	5.8	-

TABLE 4A

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #1 - PERFORMANCE BETWEEN PEA AND TOMATO PACKS

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 CONC.-PPM	REMARKS
Aug. 1	65	210,000	8,480	-	21	44.1	0	1.0	7.4	430	3.9	
2	65	210,000	8,480	-	17	35.7	0	"	(-0.3)	430	3.5	
3	-	-	-	-	-	-	0	"	(-0.3)	430	-	AVERAGE VOLUME LOSS
4	-	-	-	-	-	-	0	"	(-0.2)	430	-	2,570 GALLONS/DAY
5	62	197,000	8,250	-	17	33.5	0	"	-1.0	430	3.8	
6	62	197,000	8,250	-	17	33.5	0	"	-14.8	430	6.7	
7	62	197,000	8,250	-	24	47.3	0	"	18.7	-	6.5	
8	62	197,000	8,250	-	14	27.6	0	1.07	-1.1	11,500	6.5	
9	62	197,000	8,250	Small	14	27.6	Negl.	"	(+0.2)	9,500	6.1	
10	65	210,000*	8,480	"	-	-	"	"	(0.2)	6,910	7.2	NET VOLUME ADDITION
11	68	223,000*	8,700	"	-	-	"	"	(0.2)	5,040	7.7	FOR WHOLE PERIOD 79,000
12	73	247,000*	9,090	"	16	31.5	"	"	6.8	3,170	7.6	GALLONS ESTIMATED LOSSES
13	75	256,000*	9,240	"	12	23.6	"	"	-9.0	2,740	7.7	(3,700 GALLONS/DAY)
14	79	276,000*	9,560	-	16	31.5	0	"	-3.1	1,590	8.0	* INCREASES DUE TO ADDITION OF CITY WATER
15	79	276,000	9,560	508	17	33.5	21.9	2.18	-9.8	1,010	7.5	
16	78	271,000	9,490	-	32	63.0	0	"	(7.0)	720	8.1	
17	77	266,000	9,400	-	-	-	0	"	(7.0)	720	-	AVERAGE VOLUME LOSS
18	-	-	-	-	-	-	0	"	(7.0)	720	8.3	4,900 GALLONS/DAY
19	76	261,000	9,330	-	18	35.5	0	"	-32.3	580	8.6	
20	74	252,000	9,170	-	33	65.6	0	"	37.8	580	8.9	
21	75	256,000	9,240	124	13	25.6	12.3	"	10.1	10,100	8.7	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 CONC.-PPM	REMARKS
Aug. 22	74	252,000	9,170	-	13	25.6	0	-	-	-	6.7	
23	74	252.000	9,170	-	13	25.6	0	-	-	-	6.1	AVERAGE VOLUME LOSS
24	74	252,000	9,170	-	-	-	0	-	-	-	-	2,800 GALLONS/DAY
25	72	242,000	9,010	-	-	-	0	-	-	-	-	
26	72	242,000	9,010	-	-	-	0	-	-	-	7.5	
AVERAGE	70½	236,000	8,900	316	18.1	35.9	1.30	1.42	1.45	2,873	6.9	AVERAGED UP TO AUG./23

APPENDIX A

TABLE 5

RESULTS OF AERATED LAGOON #1 DURING TOMATO PACK

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
Aug. 15	508	17	10	96.5	98	292	-	-	1080	88	92	3	21	84	20	-	7.5	8.3	0.7
21	124	13	13	89.5	89.5	21	63	0	378	73	81	7	12	48	20	-	8.7	8.6	7.0
27	206	18	19	91.4	91	115	79	31.3	575	69	88	7	22	88	22	8.3	9.2	9.0	
28	544	20	15	96.4	97	348	88	74.8	930	91	90.2	4	32	128	22	6.7	5.6	9.2	
29	668	18	11	97.1	98	249	45	82	1085	95	91.3	6	58	232	22	2.2	1.1	9.0	
30	640	17	12	97.4	98	631	54	91.4	976	98	90	4	38	152	22	1.8	1.8	8.5	
31	652	17	11	97.5	98.5	185	56	69.8	940	87	90.8	4	39	156	21	3.5	3.4	8.4	
Sept. 1	-	-	10	-	-	-	-	-	-	77	-	-	-	-	23	0	7.7	8.4	
2	-	9	5	-	-	17	60	0	236	68	71.1	5	-	-	21	6.3	6.1	8.9	
3	164	10	6	94	96.5	86	78	9.3	171	64	62.6	5	11	44	21	5.7	5.3	8.8	
4	-	12	5	-	-	276	88	68.1	465	79	83	5	-	-	20	5.0	6.0	8.6	
5	244	13	11	94.8	95.5	109	69	36.6	303	75	75.4	5	17	68	20	5.8	5.9	8.6	
6	480	21	15	95.6	97	233	49	79	492	102	79.3	5	32	128	20	4.6	5.4	8.8	
7	228	20	12	91.3	95	689	41	94.1	540	82	85	15	54	216	21	2.4	2.9	8.5	
8	228	25	12	89	95	165	48	71	210	78	62.8	25	81	324	21	1.3	1.9	8.0	
9	127	10	9	92.1	93	256	23	91	218	75	65.6	10	19	76	22	1.7	2.6	8.3	
10	257	-	-	-	-	378	40	89.5	835	78	90.6	5	18	72	22	2.5	1.8	8.2	
11	148	6	16	96	89	218	46	78.9	575	74	87	5	11	44	21	3.5	-	8.5	
12	220	16	8	92.8	96.5	200	62	69	617	86	86.1	5	17	68	21	3.9	3.9	8.3	
13	-	-	-	-	-	393	99	74.9	218	98	55	5	-	-	18	4.2	6.6	8.5	
14	144	16	8	88.9	94.5	138	54	60.9	190	99	47.9	5	11	44	18	6.9	7.3	8.6	

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
Sept.15	206	20	10	90.4	95	353	46	87	695	130	81.4	5	16	64	18	6.3	8.3	8.4	
16	127	16	8	87.4	94	-	74	-	192	86	55.2	5	9	36	18	6.3	7.4	8.4	very
17	305	12	8	96.1	97.5	266	44	83.5	509	90	82.4	5	23	92	20	5.7	7.3	8.4	low
18	-	-	-	-	-	-	-	-	-	-	-	5	-	-	20	4.5	4.4	-	less
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	than
20	357	11	10	97	97.5	186	46	75.3	726	94	87	10	50	200	20	3.8	4.1	7.9	2 cfm
21	225	9	9	96	96	152	58	61.8	313	95	69.6	10	32	128	20	4.5	4.9	7.9	
22	-	-	4	-	-	-	-	-	-	82	-	10	-	-	18	4.9	7.4	8.0	
23	206	10	7	95.2	97	114	30	73.7	473	90	81	10	30	120	17	8.1	8.1	-	
24	238	25	10	89.5	96	86	43	50	543	94	82.7	15	51	204	16	8.3	8.2	-	
25	125	18	10	85.6	92	93	34	63.5	240	112	53.3	15	26	104	16	8.3	7.7	-	
26	350	16	13	95.5	96.5	284	40	86	524	87	83.4	15	76	304	18	7.1	6.1	-	
27	258	18	11	93	96	199	50	75	631	91	85.6	20	72	288	18	3.8	4.7	8.5	
28	564	29	20	94.9	96.5	167	66	60.5	835	126	85	20	162	648	18	1.8	7.2	8.4	
29	172	31	19	82	89	343	57	83.5	346	102	70.5	20	51	204	17	1.3	1.0	8.0	
30	822	26	17	97	98	119	58	51.2	1025	99	90.4	20	239	956	16	2.1	2.3	8.0	
Oct. 1	490	-	-	-	-	130	57	56	685	114	83.4	20	142	568	20	1.8	2.0	7.9	
2	468	33	11	93	97.5	111	46	58.5	551	110	80	20	137	548	18	0.6	0.9	7.9	
3	1184	38	31	96.9	97.5	180	50	72.2	1240	122	90.1	25	428	1712	17	0.3	0.6	8.0	
4	448	68	7	84.7	98.5	322	54	83.3	518	137	73.5	25	162	648	16	0.3	1.1	8.0	
5	496	80+	64	-	86	274	26	90.6	651	180	72.4	25	178	712	16	0.2	0.7	7.9	
6	-	-	31	-	-	-	-	-	-	172	-	-	-	-	16	0	0.3	8.0	
7	600	70	38	88.4	94	208	77	63	792	189	76.1	25	216	864	18	0	0.3	7.4	
8	1060	76+	77+	-	-	343	52	84.7	1670	199	88.1	25	380	1520	17	0.3	0	7.2	
9	-	78+	79+	-	-	-	-	-	-	244	-	0	0	0	16	-	0	6.8	

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
Oct. 10	-	79+	75	-	-	-	51	-	-	248	-	0	0	0	15	0.5	0.5	7.3	very
11	-	78+	45	-	-	-	55	-	-	228	-	0	0	0	16	0.4	0.5	8.0	low
12	-	28	15	-	-	-	103	-	-	208	-	0	0	0	15	0.5	0.6	7.7	
13	-	-	34	-	-	-	-	-	-	204	-	0	0	0	-	-	4.9	7 8	
14	-	-	38	-	-	-	-	-	-	204	-	0	0	0	-	-	5.8	7.9	
15	536	84	28	84	95	135	76	43.6	532	192	64	25	195	780	16	5.7	5.5	7.9	
16	1460	150	78	87.3	95	406	158	61.2	1570	259	83.5	30	640	2560	15	0.2	0.3	7.5	
17	140	107	34	23.6	76	89	103	0	226	272	0	20	43	172	15	0.3	0.7	7.4	
18	508	142	57	72	89	889	207	76.8	918	262	71.5	20	150	600	15	0.1	0	7.2	

TABLE 5A

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #1 - TOMATO PACK PERFORMANCE

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 -PPM	REMARKS
Aug. 27	72½	243,000	9,050	206	18	43.8	22	0.68	14.7	2,000-	8.8	
28	74	252,000	9,170	544	20	50.4	32	"	35.6	"	6.2	
29	75	256,000	9,230	668	18	46.1	58	"	59.9	"	1.6	
30	75	256,000	9,230	640	17	43.5	38	"	37.3	"	1.8	AVERAGE VOLUME LOSS
31	75	256,000	9,230	652	17	43.5	39	"	(28.6)	"	3.5	4,100 GALLONS/DAY
Sept. 1	75	256,000	9,230	-	-	-	0	"	(28.6)	"	3.9	
2	77	265,000	9,400	(125)	9	23.9	(9)	"	(5.7)	"	6.2	
3	77	265,000	9,400	164	10	26.5	11	2.3	3.4	"	5.5	
4	77	265,000	9,400	(200)	12	31.8	(14)	"	9.3	"	5.5	
5	76½	263,000	9,370	244	13	34.2	17	"	-5.9	"	5.9	
6	76	261,000	9,330	480	21	54.8	32	"	30.5	"	5.0	AVERAGE VOLUME LOSS
7	78	270,000	9,490	228	20	54.0	54	"	39.4	"	2.7	14,000 GALLONS/DAY
8	77	265,000	9,400	228	25	66.3	81	"	118	"	1.6	
9	78	270,000	9,490	127	10	27.0	19	"	(22.3)	"	2.2	
10	77	265,000	9,400	257	-	-	18	1.3	(22.3)	"	2.2	
11	76½	263,000	9,370	148	6	15.8	11	"	-16.3	"	3.5	
12	76	261,000	9,330	220	16	41.8	17	"	(11.7)	"	3.9	AVERAGE VOLUME LOSS
13	76	261,000	9,330	(120)	-	-	9	"	(11.7)	"	5.4	8,500 GALLONS/DAY
14	76	261,000	9,330	144	16	41.8	11	"	-0.1	"	7.1	
15	75½	258,000	9,230	206	20	51.6	16	"	25.3	"	7.3	
16	75	256,000	9,230	127	16	41.0	9	"	18.0	"	6.9	

DATE 1963	LAGOON DEPTH- IN.	LAGOON VOLUME- GAL.	LAGOON SURFACE- FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS. O_2 -PPM	REMARKS
Sept.17	75	256,000	9,230	305	12	30.7	23	0.96	(7.0)	2,000-	6.5	
18	75	256,000	9,230	-	-	-	0	"	(7.0)	"	4.5	
19	-	-	-	-	-	-	0	"	(7.0)	"	-	
20	78	270,000	9,490	357	11	29.7	50	"	54.1	"	4.0	AVERAGE VOLUME LOSS
21	78	273,000	9,520	225	9	24.6	32	"	(24.0)	"	4.7	9,100 GALLONS/DAY
22	79	276,000	9,560	147	-	-	21	"	(24.0)	"	6.2	
23	79	276,000	9,560	206	10	27.6	30	"	-12.4	"	8.1	
24	79	276,000	9,560	238	25	69.0	51	3.5	65.5	"	8.3	
25	80½	283,000	9,680	125	18	51.0	26	"	26.3	"	8.0	
26	83	295,000	9,880	350	16	47.2	76	"	63.7	"	6.6	
27	86	311,000	10,130	258	18	56.0	72	"	28.8	"	4.3	AVERAGE VOLUME LOSS
28	89	330,000	10,410	564	29	95.7	162	"	149	"	4.5	15,100 GALLONS/DAY
29	91	338,000	10,520	172	31	105	51	"	64.6	"	1.2	
30	91	338,000	10,520	822	26	87.9	239	"	(222)	"	2.2	
Oct. 1	93	350,000	10,700	490	-	-	142	18+	(110+)	"	1.9	
2	93	350,000	10,700	468	33	115	137	"	101	"	0.8	
3	93	350,000	10,700	1,184	38	133	428	"	305	"	0.5	
4	93	350,000	10,700	448	68	238	162	"	96	"	0.7	AVERAGE VOLUME LOSS
5	94	358,000	10,820	496	80+	286+	178	"	(89+)	"	0.5	31,600 GALLONS/DAY
6	95	360,000	10,860	-	-	-	0	"	(89+)	"	0.2	
7	94½	358,000	10,820	600	70	251	216	"	173-	"	0.2	(SEPTIC ODORS)
8	95½	363,000	10,900	1,060	76+	276+	380	8+	(363)	"	0.2	(SEPTIC ODORS)
9	96	366,000	10,940	-	78+	285+	0	"	(10+)	"	0.0	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BOD - POUNDS PER DAY BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 -PPM	REMARKS
Oct. 10	91	338,000	10,520	-	79+	267+	0	29+	(- 6)	2,000-	0.5	
11	91	338,000	10,520	-	78+	264+	0	"	165	"	0.5	AVERAGE VOLUME LOSS
12	89	327,000	10,370	-	28	91.6	0	"	(-65.8)	"	0.6	11,100 GALLONS/DAY
13	88	322,000	10,300	-	-	-	0	"	(-65.8)	"	4.9	
14	87	316,000	10,210	-	-	-	0	"	(-65.8)	"	5.8	
15	87	316,000	10,210	536	84	265	195	26	-82	"	5.6	
16	92	344,000	10,610	1,460	150	516	640	"	770	"	0.3	AVERAGE VOLUME LOSS
17	94	355,000	10,780	140	107	360	43	"	-128	"	0.4	21,300 GALLONS/DAY
18	94	355,000	10,780	508	142	505	150	"	146	"	0.1	
AVERAGE	83	297,538	9,893	399	37+	121.3+	77	9.3+	60.7	2,000-	3.64	

APPENDIX A

TABLE 6

RESULTS OF AERATED LAGOON #1 AFTER TOMATO PACK

DATE 1963	BOD UNFILT PPM	BOD FILT PPM	COD PPM	SUSP. SOLIDS PPM	TEMP °C	PH	DO DAY PPM	AIR RATE CFM
Oct.19	132	76	277	78	17	7.5	0	about
20	134	60	250	106	16	7.6	0.1	2 CFM
21	96	30	227	100	15	7.7	0.3	
22	100	32	228	101	15	7.7	0.5	
23	84	20	218	134	15	7.7	1.5	
24	78	24	207	133	15	7.8	2.6	
25	102	36	220	118	16	7.8	3.9	NIL-
26	114	30	224	113	16	8.3	4.9	blower
27	100	28	212	78	15	8.0	4.4	off
28	40	31	212	112	15	7.5	2.7	
29	74	19	212	111	13	7.4	0.5	
30	80	19	235	108	13	7.9	7.0	
31	66	17	232	102	11	7.7	3.8	
Nov. 1	80	13	216	111	10	7.5	1.8	
2					9	7.8	4.4	
3					7	7.9	7.9	
4					7	7.8	7.2	
5					8	7.8	7.4	
6					10	8.3	14.1	

TABLE 6A

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #1 - PERFORMANCE FOLLOWING TOMATO PACK

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	EFFLUENT BOD-PPM	LAGOON BOD-LB	BOD - LB/DAY EFFLUENT	BOD - LB/DAY BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS. O_2 -PPM	REMARKS
Oct. 19	96	366,000	10,950	132	483	8.19	10.8	(2880)	0.0	SEPTIC ODORS
20	92½	347,000	10,650	134	464	"	132.8	"	0.03	" "
21	90½	336,000	10,480	96	323	"	-12.2	"	0.17	AVERAGE VOLUME LOSS
22	89	327,000	10,370	100	327	"	44.8	"	0.20	7,910 GALLONS/DAY
23	89	327,000	10,370	84	274	"	14.8	"	1.5	
24	88	322,000	10,290	78	251	"	-80.2	"	2.6	
25	87	317,000	10,220	102	323	"	-34.2	"	3.9	
26	86	312,000	10,130	114	349	5.77	37.2	"	4.9	
27	85	306,000	10,050	100	306	"	180.2	"	4.4	
28	84	301,000	9,980	40	120	"	-108.8	"	2.7	AVERAGE VOLUME LOSS
29	84	301,000	9,980	74	223	"	-11.8	"	0.5	7,290 GALLONS/DAY
30	81	286,000	9,720	80	229	"	44.2	"	7.0	
31	80	271,000	9,640	66	179	"	-43.8	"	3.8	
Nov. 1	80	271,000	9,640	80	217	"	-	"	1.8	
2	79	266,000	9,560		-	-	-	"	4.4	
3	78	261,000	9,490		-	-	-	"	7.9	
4	78	261,000	9,490		-	-	-	"	7.1	
5	78	261,000	9,490		-	-	-	"	7.4	
6	78	261,000	9,490		-	-	-	"	14.1	
AVERAGE	86½	313,600	10,180	91.4	291	6.98	13.4	(2880)	2.4	AVERAGED FROM OCT. 19-31

APPENDIX A

TABLE 7

RESULTS OF AERATED LAGOON #2 DURING PEA PACK

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
June 24	2107	41	-	98	-	1024	19	98	3406	69	98	3.5	105	420	23	1.4	8.4	7.9	17.4
25	795	54	-	93.3	-	157	49	69	887	112	87.4	3.5	39	156	26	2.6	0.3	7.5	17.4
26	638	36	-	94.5	-	182	48	73.6	937	81	91.4	3.5	32	128	26	3.0	3.4	7.7	17.4
27	560	-	12	-	98	309	109	64.8	841	110	87	8	78	312	25	3.0	2.5	7.7	17.5
28	344	-	22	-	93.5	467	71	85	615	157	74.6	6	30	120	25	2.4	-	7.6	17.4
29	712	-	58	-	92	333	59	82.3	1070	161	85	6	65	260	27	1.8	6.2	7.5	16.4
30	760	26	-	96.6	-	307	105	66	944	213	77.5	5	51	204	27	0.3	1.1	7.4	15.0
July 1	304	28	-	90.8	-	237	89	62.5	737	234	68.3	5	22	88	27	0.2	0.6	7.2	14.1
2	380	36	-	90.6	-	570	58	90	790	222	72	3.5	18	72	28	0	1.8	7.3	14.1
3	340	75	-	78	-	248	-	-	716	118	83.6	3.5	16	64	27	0.4	3.9	7.3	14.1
4	240	34	-	86	-	458	26	94.5	755	110	85.5	3.5	12	48	25	3.7	6.8	7.6	14.0
5	-	17	-	-	-	142	-	-	758	152	79.9	4	-	-	25	4.7	-	8.0	13.3
6	756	76	-	90	-	190	105	44.7	-	172	-	4	45	180	25	5.0	6.0	8.1	11.0
7	-	-	41	-	-	-	-	-	-	194	-	0	0	0	25	5.7	8.4	8.1	-
8	181	-	25	-	86	75	-	-	237	193	18.6	4	10	40	23	7.0	8.4	8.2	-
9	240	36	26	85	89	184	150	18.5	282	274	2.8	4	17	68	21	5.4	4.7	8.2	-
10	982	26	46	97.4	95.5	262	87	67	1170	167	86	8	118	472	21	6.6	-	8.2	13.4
11	220	8	27	96.4	88	168	115	31.5	224	213	4.9	8	26	104	21	4.3	4.0	7.9	13.4
12	-	-	-	-	-	-	-	-	-	206	-	0	0	0	22	5.7	5.0	8.2	11.3
13	-	-	-	-	-	-	-	-	-	193	-	0	0	0	24	3.0	5.0	8.1	9.1
14	281	31	4	89	86.5	118	58	50.8	588	137	76.6	5	19	76	24	1.3	2.9	7.6	13.3

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
July 15	430	39	26	91	94	211	53	75	226	113	50	5	30	120	21	3.4	4.1	7.6	13.3
16	930	35	18	96.2	98	236	54	77.1	1400	143	89.7	5	65	260	23	2.6	2.5	7.5	13.3
17	-	30	24	-	-	443	14	97	124	143	0	5	-	-	23	1.3	2.0	7.4	7.6
18	148	31	24	79.1	84	441	34	92.2	153	124	19	5	11	44	24	2.6	3.9	7.6	7.6
19	74	20	17	73	77	7	36	0	163	140	14.1	3	3	12	25	3.2	4.6	7.7	5.3
20	288	47	24	83.7	92	223	10	95.5	357	97	73	3	11	44	24	3.4	3.7	7.7	8.7
21	424	48	39	88.9	91	124	71	42.7	434	97	77.6	3	17	68	23	3.2	5.6	7.7	12
22	-	38	53	-	-	56	76	0	287	104	63.7	3	-	-	24	3.8	2.8	-	12
23	108	45	18	58.4	83.5	69	127	0	153	149	2.6	3	4	16	24	3.3	3.3	-	12
24	466	57	14	87.8	97	221	171	22.6	965	156	83.9	5	31	124	25	5.8	3.7	7.7	11.5
25	-	33	25	-	-	176	190	0	-	129	-	0	0	0	26	3.9	3.8	7.7	10.8
26	501	38	26	87.9	95	208	112	46.1	800	117	85.4	4	29	116	26	5.0	4.7	7.7	10.8
27	444	26	14	94.3	97	293	331	0	746	156	79	4	26	104	27	5.8	6.4	7.8	12
28	239	22	18	91	92.5	80	69	13.8	428	140	67.2	4	14	56	27	5.7	6.5	7.8	12.1
29	312	35	33	89	89.5	83	32	61.5	467	110	76.5	4	19	76	27	4.9	3.8	7.8	12.1
30	408	30	27	92.5	93	996	139	86	728	108	85	4	25	100	27	4.7	3.6	7.8	12.1
31	152	39	37	94.5	76	299	143	52.2	284	108	62	4	9	36	26	-	3.8	7.6	10.3

TABLE 7A

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #2 - PEA PACK PERFORMANCE

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 -PPM	REMARKS
June 24	46	150,000	6,930	2,107	41	61.5	105	0.15	84.4	25,000	4.9	
25	46½	152,000	6,990	795	54	82.0	39	"	63.9	25,000	1.5	
26	48	158,000	7,100	638	36	56.9	32	"	(33.6)	25,000	3.2	
27	49½	163,000	7,190	560	-	-	78	"	(79.6)	25,200	2.8	AVERAGE VOLUME LOSS
28	51	169,000	7,300	344	-	-	30	"	(31.6)	25,000	2.4	390 GALLONS/DAY
29	51	169,000	7,300	712	-	-	65	"	(66.6)	23,600	4.0	
30	57	192,000	7,710	760	26	49.9	51	"	45.3	21,600	0.7	
July 1	58½	198,000	7,820	304	28	55.4	22	1.8	-1.1	20,300	0.4	
2	62	213,000	8,070	380	36	76.7	18	"	-67.1	20,300	0.9	
3	62	213,000	8,070	340	75	160	16	"	102	20,300	2.2	
4	62	213,000	8,070	240	34	72.4	12	"	45.4	20,200	5.3	AVERAGE VOLUME LOSS
5	63½	219,000	8,190	(240)	17	37.2	(13)	"	(-116.6)	19,200	4.7	4,040 GALLONS/DAY
6	63	217,000	8,140	756	76	165	45	"	(72.9)	15,800	5.5	
7	63	217,000	8,140	-	-	-	0	"	(27.9)	-	7.1	
8	61	209,000	8,000	181	-	-	10	2.5	(37.2)	-	7.7	
9	61½	211,000	8,030	240	36	76.0	17	"	35.6	-	5.1	
10	61½	211,000	8,030	982	26	54.9	118	"	153	19,300	6.6	
11	62	213,000	8,070	220	8	17.0	26	"	(6.8)	19,300	4.2	AVERAGE VOLUME LOSS
12	62	213,000	8,070	-	-	-	0	"	(-19.2)	16,300	5.1	9,060 GALLONS/DAY
13	62	213,000	8,070	-	-	-	0	"	(-19.2)	13,100	4.0	
14	62½	216,000	8,110	281	31	67.0	19	"	4.0	19,200	2.2	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BOD - POUNDS PER DAY BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O$_2$ -PPM	REMARKS
July 15	60	204,000	7,930	430	39	79.5	30	1.3	35.0	19,200	3.8	
16	61	209,000	8,000	930	35	73.2	65	"	71.8	19,200	2.6	
17	63	217,000	8,140	(90)	30	65.1	(63)	"	(59.5)	11,000	1.7	
18	63	217,000	8,140	148	31	67.3	11	"	33.6	11,000	3.3	AVERAGE VOLUME LOSS
19	63	217,000	8,140	74	20	43.4	3	"	-56.9	7,620	3.9	3,700 GALLONS/DAY
20	63	217,000	8,140	288	47	102	11	"	6.7	12,500	3.6	
21	63½	219,000	8,190	424	48	105	17	"	36.7	17,300	4.4	
22	64	221,000	8,220	(150)	38	84.0	6.5	1.7	(-9.7)	17,300	3.3	
23	(63½)	(219,000)	(8,190)	108	45	(98.5)	4	"	(-23.2)	17,300	3.3	
24	63	217,000	8,140	466	57	124	31	"	81.7	16,600	4.8	AVERAGE VOLUME LOSS
25	63	217,000	8,140	-	33	71.6	0	"	-12.6	15,600	3.9	4,470 GALLONS/DAY
26	63	217,000	8,140	501	38	82.5	29	"	52.3	15,600	4.9	
27	64	221,000	8,220	444	26	57.5	26	"	31.7	17,300	6.1	
28	65½	228,000	8,320	239	22	50.1	14	"	-17.4	17,400	6.1	
29	65½	228,000	8,320	312	35	79.8	19	1.5	28.0	17,400	4.4	
30	66	231,000	8,360	408	30	69.3	25	"	2.8	17,400	4.2	AVERAGE VOLUME LOSS
31	66	231,000	8,360	152	39	90.0	9	"	54.4	14,800	3.8	4,260 GALLONS/DAY
AVERAGES	60½	206,816	7,960	379	36.7	76.6	28.4	1.53	27.4	18,235	3.91	

APPENDIX A

TABLE 8

RESULTS OF AERATED LAGOON #2 BETWEEN PEA AND TOMATO PACKS

DATE 1963	BOD UNFILT PPM	BOD FILT PPM	COD PPM	SUSP. SOLIDS PPM	TEMP °C	PH	D.O DAY PPM	AIR RATE CFM
Aug.1	19	19	97	82	25	7.7	5.6	
2	19	16	86	98	24	7.8	5.2	
3	-	-	-	-	-	-	-	
4	-	-	-	-	-	-	-	
5	16	18	90	100	22	7.9	5.4	
6	27	23	97	131	25	8.0	7.2	
7	33	11	93	93	25	8.0	6.7	
8	15	12	93	62	25	8.0	6.9	17.2
9	21	20	77	59	24	8.0	6.6	17.0
10	-	-	-	-	23	8.4	7.7	16.9
11	-	-	-	-	23	8.6	8.2	16.4
12	20	9	88	77	23	8.6	7.6	14.8
13	15	10	85	76	22	8.6	7.7	13.9
14	16	13	92	51	20	8.8	8.2	12.7
15	17	10	95	43	20	8.8	7.8	10.7
16	42	27	109	43	20	8.8	8.1	10
17	-	-	-	-	-	-	-	
18	-	-	-	-	-	-	-	
19	23	12	95	85	20	8.5	8.4	
20	54	21	84	100	20	8.5	8.8	
21	17	7	105	122	21	8.4	8.6	
22	27	8	112	115	23	8.1	7.8	
23	16	8	108	89	22	7.9	6.0	

TABLE 8A

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

AERATED LAGOON #2 - PERFORMANCE BETWEEN PEA AND TOMATO PACKS

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BOD - POUNDS PER DAY BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 CONC.-PPM	REMARKS
Aug. 1	65	227,000	8,300	-	19	43.1	0	.48	-.48	14,832	5.6	
2	65	227,000	8,300	-	19	43.1	0	"	(2.55)	14,400	5.3	
3	-	-	-	-	-	-	0	"	(2.55)	-	-	
4	-	-	-	-	-	-	0	"	(2.55)	-	-	AVERAGE VOLUME LOSS
5	62	213,000	8,100	-	16	34.0	0	"	-23.98	-	5.5	2,000 GALLONS/DAY
6	62	213,000	8,100	-	27	57.5	0	"	-13.38	-	7.2	
7	62	213,000	8,100	-	33	70.3	0	"	37.82	-	6.7	
8	62	213,000	8,100	-	15	32.0	0	.42	-13.12	24,768	7.0	
9	62	213,000	8,100	Small	21	44.7	Negl.	"	(-1.79)	24,480	6.5	NET VOLUME ADDITION
10	65	227,000*	8,300	"	-	-	"	"	(-1.79)	24,336	7.7	FOR WHOLE PERIOD
11	67	235,000*	8,450	"	-	-	"	"	(-1.79)	23,616	8.3	72,000 GALLONS
12	69	244,000*	8,580	"	20	48.8	"	"	8.58	21.312	7.9	ESTIMATED AVERAGE LOSS
13	74	265,000*	8,980	"	15	39.8	"	"	-6.22	19.996	8.0	2,020 GALLONS/DAY
14	78	285,000*	9,270	-	16	45.6	0	"	-3.32	18,288	8.2	* INCREASES DUE TO
												ADDITION OF CITY WATER
15	78	285,000	9,270	508	17	48.5	21.9	1.79	-51.09	15,408	7.8	
16	78	285,000	9,270	-	42	119.7	0	"	(17.01)	14,400	8.1	
17	-	-	-	-	-	-	0	"	(17.01)	-	-	AVERAGE VOLUME LOSS
18	-	-	-	-	-	-	0	"	(17.01)	-	-	2,035 GALLONS/DAY
19	76	275,000	9,120	-	23	63.3	0	"	-70.29	-	8.4	
20	69	244,000	8,590	-	54	131.8	0	"	88.51	-	8.8	
21	69	244,000	8,590	124	17	41.5	12.3	"	-24.99	-	8.6	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS.O_2 CONC.-PPM	REMARKS
Aug. 22	78	285,000	9,270	-	27	77.0	0	.56	38.04	-	7.8	
23	68	240,000	8,500	-	16	38.4	0	"	-	-	6.0	AVERAGE VOLUME LOSS
24	68	240,000	8,500	-	-	-	0	"	-	-	-	13,500 GALLONS/DAY
25	66	231,000	8,370	-	-	-	0	"	-	-	-	
26	66	231,000	8,370	-	-	-	0	"			7.9	
AVERAGE	69	244,000	8,610	316	23	57.6	1.5	.865	0.882	19,800	7.4	AVERAGED UP TO AUG./23

APPENDIX A

TABLE 9

RESULTS OF AERATED LAGOON #2 DURING TOMATO PACK

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
Aug. 15	508	17	10	96.5	98.1	292	43	85.4	1080	95	91.1	3	20	80	20	-	7.8	8.8	10.7
21	124	17	7	86.4	94.5	21	122	0	378	105	72.2	7	12	48	21	-	6.0	8.1	-
27	206	18	14	91.4	93	115	127	0	575	87	85	7	21	84	22	7.7	8.4	9.0	-
28	544	27	13	95	97.5	348	169	51.5	930	120	87	4	32	128	22	6.9	7.1	9.0	-
29	668	27	13	96	98	249	99	60.4	1085	102	90.6	5	46	184	21	5.2	4.1	8.8	-
30	640	27	13	96	98	631	111	82.5	976	131	86.6	4	38	152	22	4.2	4.2	8.4	-
31	652	24	10	96.3	98.5	185	59	68	940	124	87	4	39	156	21	4.1	4.0	8.2	-
Sept. 1	-	-	8	-	-	-	-	-	-	87	-	-	-	-	22	-	8.1	8.5	-
2	-	8	6	-	-	17	93	0	236	93	60.6	5	-	-	21	6.4	6.5	8.3	-
3	164	8	6	95.2	96.5	86	76	11.6	171	89	48	5	11	44	21	6.3	6.0	8.2	3.5
4	-	16	6	-	-	276	102	63	465	75	83.9	5	-	-	20	5.2	6.8	8.1	3.5
5	244	6	5	97.6	98	109	92	15.6	303	71	76.6	5	17	68	20	6.3	6.6	8.0	0
6	480	23	17	95.2	96.5	233	67	71.2	492	102	79.5	5	33	132	20	4.1	5.7	8.2	-
7	228	22	14	90.5	94	689	44	93.7	540	109	79.9	15	49	196	20	2.0	3.3	8.0	0
8	228	37	15	83.9	93.5	165	61	63	210	98	53.4	15	49	196	21	1.7	4.2	7.6	-
9	127	10	9	92.1	93	256	43	83.2	218	90	58.7	10	17	68	21	2.6	3.2	7.9	-
10	257	-	-	-	-	378	51	86.5	835	82	90.3	5	18	72	22	0.7	0.7	7.6	-
11	148	5	16	96.6	89	218	67	69.3	575	90	84.4	5	11	44	21	1.6	-	7.7	-
12	220	-	7	-	97	200	51	74.5	617	90	85.5	5	15	60	21	3.4	3.5	7.8	-
13	-	-	-	-	-	393	91	77	218	109	50.0	5	-	-	18	4.6	7.4	8.3	-
14	144	18	7	87.5	95	138	67	51.4	190	111	41.5	10	20	80	18	6.9	8.0	8.2	-

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
Sept.15	206	23	9	89	96	253	63	75	695	115	83.5	10	28	112	18	4.9	6.3	8.2	-
16	127	20	8	84.3	94	-	77	-	192	94	51	10	17	68	19	4.5	6.5	8.2	
17	305	19	6	94	98	266	51	81	509	149	70.8	10	42	168	21	2.4	4.1	8.3	
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	1.5	7.9	12
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	357	22	3	94	99.5	186	47	76	726	118	83.9	15	77	308	20	6.0	6.0	7.9	
21	225	10	8	95.5	96.5	152	68	55.3	313	128	59.1	15	49	196	20	6.3	6.0	-	
22	-	-	6	-	-	-	-	-	-	100	-	15	-	-	18	6.0	6.4	7.8	
23	206	20	7	90.4	96.5	114	34	70.2	473	90	81.0	15	44	176	17	6.7	6.8	-	
24	238	-	9	-	96	86	40	53.5	543	118	78.4	20	66	264	16	4.4	4.3	-	
25	125	-	13	-	90	93	40	57	240	136	43.4	20	34	136	16	2.9	2.1	-	
26	350	21	15	94	96	284	35	87.8	524	91	82.6	20	101	404	17	1.6	1.7	-	
27	258	24	15	91	94	199	46	77	631	95	85	25	91	364	19	1.5	2.9	7.8	
28	564	23	13	96	98	167	59	64.8	835	126	85	25	200	800	18	1.2	1.0	7.8	
29	172	29	14	83	92	343	46	86.5	346	110	68.2	25	63	252	17	0.4	0.9	7.7	
30	822	32	17	96	98	119	36	69.7	1025	118	88.5	25	297	1188	16	1.3	1.7	7.9	
Oct. 1	490	-	-	-	-	130	35	73	685	110	84	25	176	704	18	0.9	0.9	7.8	
2	468	37	13	92	97	111	19	82.8	551	118	78.5	25	169	676	17	0.8	0.5	8.0	
3	1184	54	31	95.5	97.5	180	51	71.6	1240	126	89.8	22	400	1600	17	0.7	0.5	7.8	
4	448	58	29	87	94	322	58	82	518	157	69.6	20	130	520	16	0.4	0.3	7.7	
5	496	78	65	85	87	274	30	89	651	188	71.1	20	143	572	16	0.2	0.3	7.0	
6	-	-	43	-	-	-	-	-	-	144	-	20	-	-	16	-	0.5	7.4	
7	600	72	37	88	94	208	75	64	792	189	76	30	258	1032	17	0.1	0.2	7.4	
8	1060	74+	74+	93-	93-	343	7	98	1670	222	86.7	30	450	1800	17	0.0	0.0	7.0	
9	1312	78+	78+	94-	94-	269	75	72.3	1370	244	82.5	30	550	2200	16	0.0	0.0	6.9	

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION % UNFILT	BOD REDUCTION % FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH	AIR RATE CFM
Oct. 10	-	79 +	73	-	-	-	51	-	-	236	-	0	0	0	17	0.3	0.0	7.5	
11	-	78 +	67	-	-	-	90	-	-	212	-	0	0	0	16	0.4	0.6	7.7	
12	-	78 +	51	-	-	-	107	-	-	204	-	0	0	0	15	0.5	1.5	7.6	
13	-	-	49	-	-	-	-	-	-	204	-	0	0	0	16	-	6.7	8.6	
14	-	-	31	-	-	-	-	-	-	204	-	0	0	0	16	-	6.2	8.1	
15	536	74	22	86.2	96	135	79	41.5	532	181	66	25	194	776	16	5.3	4.8	7.7	
16	1460	156	143	89.5	90	406	132	67.5	1570	232	85.2	25	540	2160	16	0.2	0.5	7.5	
17	140	80	25	42.9	82	89	98	0	226	250	0	10	21	84	16	0.2	1.2	7.3	
18	508	118	56	77	89	889	131	85.4	918	254	72.4	15	114	464	16	0.2	0.0	7.2	

TABLE 9A

(PART 1)

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #2 - TOMATO PACK PERFORMANCE

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	POND BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	AIR SUPPLY CU.FT.	DISS. O_2 PPM	REMARKS
Aug. 27	66½	233,000	8,400	206	18	41.9	20.5	0.68	-2.9	-	8.1	
28	68	239,000	8,500	544	27	64.6	31.3	"	29.3	-	7.0	
29	69	244,000	8,580	668	27	65.9	48.1	"	47.4	-	4.7	AVERAGE VOLUME LOSS
30	69	244,000	8,580	640	27	65.9	36.8	"	43.4	-	4.2	2,760 GALLONS/DAY
31	69	244,000	8,580	652	24	58.6	37.5	"	(36.5)	-	4.0	
Sept. 1	69	244,000	8,580	-	-	-	0.0	"	(36.5)	-	8.1	
2	69½	246,000	8,620	(125)	8	19.7	(9.0)	"	7.2	-	6.5	
3	69½	246,000	8,620	164	8	19.7	11.8	1.76	-9.3	5,040	6.2	
4	69	244,000	8,580	(200)	16	39.0	(14.4)	"	37.1	5,040	6.1	
5	68½	242,000	8,440	244	6	14.5	17.5	"	-24.8	0	6.5	AVERAGE VOLUME LOSS
6	68	239,000	8,500	480	23	55.0	34.5	"	34.4	-	4.8	10,300 GALLONS/DAY
7	68½	242,000	8,440	228	22	53.3	49.3	"	12.3	0	2.6	
8	68	239,000	8,500	228	37	88.5	49.3	"	110.7	-	3.0	
9	71	253,000	8,740	127	10	25.3	18.3	"	(22.4)	-	2.9	
10	71	253,000	8,740	257	-	-	18.5	2.29	(22.4)	-	0.6	
11	71	253,000	8,740	148	5	12.7	10.7	"	(1.0)	-	1.7	
12	69	244,000	8,580	220	-	-	15.8	"	(1.0)	-	3.4	AVERAGE VOLUME LOSS
13	69	244,000	8,580	(120)	-	-	8.6	"	(1.0)	-	6.1	14,400 GALLONS/DAY
14	69	244,000	8,580	144	18	43.9	20.8	"	6.3	-	7.5	
15	69	244,000	8,580	206	23	56.1	29.6	"	34.6	-	5.6	
16	69	244,000	8,580	127	20	48.8	18.3	"	12.1	-	5.5	
17	70½	251,000	8,700	305	19	47.7	43.9	"	(7.1)	-	3.3	(SEPTIC)
18	71	253,000	8,740	-	-	-	0.0			17,300	1.1	(ODORS)
AVERAGE	69	244,000	8,580	238	18.8	45.6	23.5	1.70	21.6	(5,000)	4.8	AVERAGED FROM AUG./27 TO SEPT./17

TABLE 9A

(PART 11)

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #2 - TOMATO PACK PERFORMANCE

DATE 1963	BOD - PPM		BOD - LBS/DAY		DISS. O_2 PPM
	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT (est)	
Sept. 19	-	-	0	-	-
20	357	22	77	4.6	6.0
21	225	10	49	2.2	6.2
22	147	-	32	-	6.2
23	206	20	44	4.3	6.8
24	238	-	66	-	4.4
25	125	-	34	-	2.5
26	350	21	101	6.1	1.7
27	258	24	91	8.5	2.2
28	564	23	200	8.2	1.1
29	172	29	63	11.6	0.7
30	822	32	297	7.6	1.5
Oct. 1	490	-	176	-	0.9
2	468	37	169	13.4	0.7
3	1184	54	400	18.2	0.6
4	448	58	130	16.8	0.4
5*	496	78	143	9.1	0.3
6*	480	-	138	-	0.5
7*	600	72	258	31.0	0.2
8*	1060	74+	450	37.7	0.0
9*	1312	78+	550	39.4	0.0
10*	-	79+	0	-	0.2

DATE 1963	BOD - PPM INFLUENT	EFFLUENT	BOD - LBS/DAY INFLUENT	EFFLUENT(est)	DISS. O_2 PPM
Oct. 11*	-	78+	0	-	0.5
12*	-	78+	0	-	1.0
13	-	-	0	-	6.7
14	-	-	0	-	6.2
15	536	74	194	26.8	5.1
16	1460	156	540	57.7	0.4
17	140	80	21	12.0	0.7
18	508	115	114	45.8	0.1
AVERAGES-	527	59+	144	19.0	2.2

ESTIMATED AVERAGES FOR THE PERIOD SEPT. 19 - OCT. 18:

LAGOON DEPTH	92.6 IN
LAGOON VOLUME	360,000 GAL
LAGOON SURFACE AREA	10,430 FT^2
AIR SUPPLY	11,000 FT^3 PER DAY

* SEPTIC ODORS PRESENT OFF LAGOON

APPENDIX A

TABLE 10

RESULTS OF AERATED LAGOON #2 AFTER TOMATO PACK

DATE 1963	BOD UNFILT PPM	BOD FILT PPM	COD PPM	SUSP. SOLIDS PPM	TEMP °C	PH	D.O DAY PPM	AIR RATE CFM
Oct 19	136	82	269	66	17	7.7	0.1	
20	126	56	257	78	17	7.4	0	
21	86	24	219	118	16	7.6	0.3	
22	72	22	199	116	15	7.7	0.6	
23	58	18	196	130	15	7.8	2.4	
24	66	18	192	133	16	7.8	3.6	
25	78	26	196	110	16	8.0	6.2	
26	58	24	208	110	16	8.7	11.4	
27	91	23	176	84	16	8.5	10.7	
28	58	18	180	100	15	8.2	8.1	
29	78	11	192	90	13	7.8	3.0	
30	38	10	208	98	13	8.5	10.1	
Oct.31	42	9	203	95	11	8.3	8.4	
Nov. 1	40	6	156	96	10	8.0	6.4	
2					8	8.2	8.6	
3					7	8.4	11.2	
4					7	8.2	9.9	
5					8	8.5	12.4	
Nov. 6					10	8.8	15.3	

TABLE 10A

BOD REMOVAL AND AIR SUPPLY CALCULATIONS

LAGOON #2 - PERFORMANCE FOLLOWING TOMATO PACK

DATE 1963		EFFLUENT BOD PPM	DISSOLVED OXYGEN PPM
Oct.	19*	136	0.1
	20*	126	0.0
	21*	86	0.3
	22*	72	0.6
	23	58	2.4
	24	66	3.6
	25	78	6.2
	26	58	11.4
	27	91	10.7
	28	58	8.1
	29	78	3.0
	30	38	10.1
	31	42	8.4
Nov.	1	40	6.4

ESTIMATED AVERAGE VOLUME, ASSUMING 10,000 GAL. LOSS DAILY = 332,000 GAL

ESTIMATED AVERAGE DEPTH = 87.5 INCHES

ESTIMATED AVERAGE SURFACE AREA = 10,000 FT^2

BOD REMOVAL	=	515 LB. IN 14 DAYS	= 37 LB./DAY
BOD EFFLUENT	=	105 LB. IN 14 DAYS	= 7.5 LB./DAY
BOD BIOREMOVED	=	410 LB. IN 14 DAYS	= 29.3LB./DAY

* SEPTIC ODORS PRESENT

APPENDIX A

TABLE 11

RESULTS OF MECHANICALLY AERATED LAGOON #3 DURING PEA PACK

SIMCAR SURFACE AERATOR, DIA. 3'6"
SPEED: 75 RPM
MAXIMUM IMMERSION AT ALL TIMES

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM MIXT.	BOD EFFLUENT PPM SUPER.	BOD % REDUCTION MIXT.	BOD % REDUCTION SUPER.	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	RETENTION DAYS	LOAD LB. BOD PER DAY	TEMP °C	DO PPM	PH
June 24	2107	760		64		1024	293	71	3406	1060	69.0	7	2.5	220	22	5.0	7.7
25	795	800		0		157	522	0	887	1012	0	7	2.5	79	23	1.8	7.1
26	638	312		51		182	356	0	937	664	29.1	7	2.5	63	23	1.6	7.4
27	560	248		56		309	260	15.8	841	520	38.2	16.5	1.05	130	24	2.0	7.4
28	344	228		33.8		467	235	49.5	615	483	37.8	10	1.80	46	24	2.8	7.6
29	712	380		46.5		333	244	26.7	1070	406	62.2	10	1.8	101	25	1.0	7.3
30	760	206		73		307	281	8.5	944	456	41.1	10	1.8	106	25	1.4	7.5
July 1	304	176		42		237	253	0	737	353	52.1	10	1.8	44	25	1.0	7.5
2	380	110		71		570	150	74	790	296	62.6	6	2.76	33	25	1.6	7.7
3	340	-		-		248	421	0	716	160	77.6	6	2.76	31	25	0.7	7.7
4	240	145		39.5		458	278	39	755	208	72.5	6	2.76	21	21	0.5	7.4
5	-	160		-		142	168	0	758	414	45.3	9	1.92	-	22	0.5	7.6
6	756	-		-		190	60	68.5	-	336	-	9	1.92	98	23	4.8	7.7
7	-	-		-		-	-	-	-	512	-	0	-	0	21	4.8	7.8
8	181	186		0		75	317	0	237	371	0	10	1.8	26	19	3.1	8.0
9	240	240		0		184	383	0	282	406	0	10	1.8	34	16	2.6	7.9
10	982	346		65		262	525	0	1170	531	53.7	15	1.11	214	17	1.4	7.8
11	220	94		57		168	421	0	224	481	0	15	1.11	48	19	1.0	7.9
12	-	-		-		-	-	-	-	445	-	0	-	0	19	6.2	8.1
13	-	-		-		-	-	-	-	417	-	0	-	0	21	6.6	8.1

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM MIXT.	BOD EFFLUENT PPM SUPER.	BOD % REDUCTION MIXT.	BOD % REDUCTION SUPER.	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	RETENTION DAYS	LOAD LB. BOD PER DAY	TEMP °C	DO PPM	PH
July 14	281	165		41.5		118	425	0	588	388	34	9	1.92	35	20	5.9	8.0
15	430	216		50		211	394	0	226	394	0	9	1.92	56	19	6.6	7.9
16	930	192		79		236	822	0	1400	504	64	10	1.8	131	22	3.6	7.7
17	-	17		-		443	559	0	124	528	0	12	1.45	-	21	3.2	7.6
18	143	185		0		441	337	23.5	153	384	0	12	1.45	26	23	4.5	7.7
19	74	104		0		7	280	0	163	330	0	12	1.45	13	23	5.2	7.9
20	288	99		65.5		223	262	0	357	345	3.4	10	1.76	41	23	5.7	8.0
21	424	119		72		124	625	0	434	304	30	10	1.76	60	22	3.5	7.9
22	-	218		-		56	264	0	287	434	0	10	1.76	-	24	3.5	-
23	108	103		4.6		69	229	0	153	321	0	10	1.76	16	22	3.7	-
24	466	130		72		221	238	0	965	331	65.7	10	1.76	65	23	3.1	8.2
25	-	145		-		176	194	0	-	418	-	10	1.76	-	23	4.1	7.8
26	501	132		73.5		208	348	0	800	412	48.5	10	1.76	74	24	4.9	7.7
27	444	92		79		293	244	16.8	746	925	0	10	1.76	63	24	4.5	7.9
28	239	87		63.5		80	333	0	428	684	0	10	1.76	34	24	4.2	8.0
29	312	74		77		83	25	70	467	125	71.1	10	1.76	44	25	4.4	7.6
30	408	118		71		996	656	34.5	728	484	33.5	10	1.76	58	25	4.2	7.7
31	152	70		54		299	636	0	284	430	0	10	1.76	22	23	4.2	7.8

TABLE 11A

BOD REMOVAL CALCULATIONS

LAGOON #3 - DURING PEA PACK

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM		LAGOON BOD-LB	BOD - POUNDS PER DAY			DISS.O_2 CONC.-PPM
				INFLUENT	EFFLUENT		INFLUENT	EFFLUENT	BIO-REMOVAL	
June 24	74	15,900	652	2107	760	120.9	212.4	76.6	106.4	3.5
25	82	18,800	712	795	800	150.3	80.1	80.6	86.8	1.9
26	86	20,200	750	638	312	63.0	64.3	31.5	44.7	1.2
27	87	20,600	762	560	248	51.1	133.1	58.9	78.3	2.0
28	87	20,600	762	344	228	47.0	49.5	32.8	- 14.6	2.8
29	87	20,600	762	712	380	78.3	102.5	54.7	83.6	1.0
30	87	20,600	762	760	206	42.5	109.4	29.7	85.9	1.4
July 1	87	20,600	762	304	176	36.3	43.8	25.3	32.1	1.0
2	87	20,600	762	380	110	22.7	32.8	9.5	(27.5)	1.7
3	87	20,600	762	340	(90)	(18.5)	29.4	7.8	(10.2)	0.7
4	87	20,600	762	240	145	29.9	20.7	12.5	5.1	0.5
5	87	20,600	762	(240)	160	33.0	31.1	20.7	(2.2)	0.5
6	87	20,600	762	756	(200)	(41.2)	98.0	25.9	(73.5)	4.8
7	87	20,600	762	-	(193)	(39.8)	0.0	0.0	(2.4)	5.4
8	85½	20,100	745	181	186	37.4	26.1	26.8	- 12.8	3.1
9	87	20,600	762	240	240	49.5	34.6	34.6	- 20.0	2.6
10	85½	20,100	745	982	346	69.5	212.1	81.7	181.6	1.4
11	84	19,500	728	220	94	18.3	60.7	20.3	(41.7)	1.0
12	84	19,500	728	-	(87)	(17.0)	0.0	0.0	(1.2)	3.7
13	84	19,500	728	-	(81)	(15.8)	0.0	0.0	(- 13.4)	3.7
14	79	17,700	689	281	165	29.2	36.4	21.4	2.1	5.9

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BOD - POUNDS PER DAY BIO-REMOVAL	DISS. O_2 CONC.-PPM
July 15	84	19,500	728	430	216	42.1	55.7	28.0	30.2	6.6
16	87	20,600	762	930	192	39.6	133.9	27.6	142.4	3.6
17	87	20,600	762	(90)	17	3.5	15.5	2.9	- 22.0	3.2
18	87	20,600	762	143	185	38.1	24.7	32.0	9.4	4.5
19	87	20,600	762	74	104	21.4	12.8	18.0	- 4.2	5.2
20	87	20,600	762	288	99	20.4	41.5	14.3	23.1	5.7
21	87	20,600	762	424	119	24.5	61.1	17.1	23.5	3.5
22	87	20,600	762	(150)	218	45.0	21.6	31.4	14.4	3.5
23	86	20,200	750	108	103	20.8	15.6	14.8	- 4.9	3.7
24	86½	20,400	756	466	130	26.5	67.1	18.7	45.0	3.1
25	87	20,600	762	-	145	29.9	0.0	20.8	- 18.1	4.1
26	87	20,600	762	501	132	27.2	72.1	19.0	61.3	4.9
27	87	20,600	762	444	92	19.0	63.9	13.2	51.8	4.5
28	87	20,600	762	239	87	17.9	34.4	12.5	24.6	4.2
29	87	20,600	762	312	74	15.2	44.9	10.6	25.2	4.4
30	87	20,600	762	408	118	24.3	58.8	17.0	52.2	4.2
31	85	19,900	738	152	70	13.9	21.9	10.1	2.5	4.2
AVERAGE	85¾	20,170	750	379	192	37.9	55.9	25.2	33.2	3.2

APPENDIX A

TABLE 12

RESULTS OF MECHANICALLY AERATED LAGOON (#3) BETWEEN PEA AND TOMATO PACKS

DATE 1963	BOD MIXTURE PPM	BOD SUPER PPM	COD MIXTURE PPM	SUSP SOLIDS PPM	TEMP °C	PH	D.O DAY PPM
Aug.1	119		397	354	21	7.9	6.4
2	114		350	321	22	7.8	6.0
3	-		-	-	-	-	-
4	-		-	-	-	-	-
5	88		294	337	20	7.9	6.6
6	74		276	293	22	8.4	7.8
7	60		280	339	22	8.3	6.8
8	54		372	250	23	8.5	7.4
9	52		210	342	23	8.4	7.4
10	-		-	-	21	8.4	8.0
11	-		-	-	19	8.4	8.6
12	41		133	137	20	8.5	8.4
13	35		125	131	20	8.5	8.0
14	66		144	132	18	8.5	7.0
15	35		128	-	19	8.5	6.8
16	350		530	210	19	7.6	1.8
17	-		-	-	17	8.0	4.0
18	-		-	-	-	-	-
19	86		288	269	15	8.4	8.2
20	107		258	245	16	8.2	8.8
21	90		565	220	19	8.0	7.2
22	79		216	139	21	8.2	7.8
23	75		150	134	21	8.2	8.0

TABLE 12A

BOD REMOVAL CALCULATIONS

LAGOON #3 - PERFORMANCE BETWEEN PEA AND TOMATO PACKS

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT²	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS. O_2 CONC.-PPM	REMARKS
Aug. 1	84	19,500	728	-	119	23.2	0	0.56	1.6	6.4	
2	81	18,400	703	-	114	21.0	0	"	(1.4)	6.0	
3	-	-	-	-	-	-	0	"	(1.4)	-	AVERAGE VOLUME LOSS
4	-	-	-	-	-	-	0	"	(1.4)	-	614 GALLONS/DAY
5	77	17,000	673	-	88	15.0	0	"	2.6	6.6	
6	74	16,000	650	-	74	11.8	0	"	1.8	7.8	
7	73	15,600	643	-	60	9.4	0	"	0.6	6.8	
8	72	15,200	636	-	54	8.2	0	3.9	- 6.4	7.4	
9	87	20,600	760	SMALL	52	10.7	NEGLIGIBLE	"	(- 3.3)	7.4	
10	89	21,500	785	"	-	-	"	"	(- 3.3)	8.0	AVERAGE VOLUME LOSS (ESTIMATED)
11	89	21,500	785	-	-	-	0	"	(- 3.3)	8.6	1,490 GALLONS/DAY; ACTUAL LOSS
12	89	21,500	785	-	41	8.8	0	"	- 2.6	8.4	8,230 GALLONS/DAY
13	89	21,500	785	-	35	7.5	0	"	- 10.0	8.0	
14	87	20,600	760	-	66	13.6	0	"	2.5	7.0	
15	87	20,600	760	508	35	7.2	73.3	"	4.5	6.8	
16	87	20,600	760	-	350	72.1	0	3.1	(15.3)	1.8	
17	85	19,900	739	-	-	-	0	"	(15.3)	4.0	
18	-	-	-	-	-	-	0	"	(15.3)	-	AVERAGE VOLUME LOSS
19	84	19,500	728	-	86	16.8	0	"	- 8.8	8.2	2,360 GALLONS/DAY
20	88	21,000	772	-	107	22.5	0	"	0.5	8.8	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS.O_2 CONC.-PPM	REMARKS
Aug. 21	88	21,000	772	124	90	18.9	24.8	3.1	23.6	7.2	
22	89	21,500	785	-	79	17.0	0	"	-	7.8	
23	-	-	-	-	75	-	0	"		8.0	
AVERAGE	84¼	19,630	737	316	89.7	17.7	4.27	2.6	2.38	7.05	

APPENDIX A

TABLE 13

RESULTS OF MECHANICALLY AERATED LAGOON #3 DURING TOMATO PACK

SIMCAR SURFACE AERATOR, DIA. 3'6"
SPEED: 75 RPM
MAXIMUM IMMERSION AT ALL TIMES

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM MIXT.	BOD EFFLUENT PPM SUPER.	BOD % REDUCTION MIXT.	BOD % REDUCTION SUPER.	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	RETENTION DAYS	LOAD LB. BOD PER DAY	TEMP °C	DO PPM	PH
Aug. 15	508	35	-	93	-	292	-	-	1080	128	93.6	10	1.76	72	19	6.8	8.5
21	124	90	-	27.5	-	21	220	0	378	565	-	14	1.23	25	19	7.2	8.1
27	206	70	-	66	-	115	139	0	575	149	74.1	10	1.76	30	17	8.4	8.8
28	544	135	61	75	89	348	123	65	930	233	71.4	8	2.12	66	17	7.0	8.2
29	668	341	154	49	77	249	261	0	1085	655	39.6	10	1.76	94	21	1.0	7.5
30	640	247	73	62	89	631	230	63.5	976	583	40.3	6	2.82	58	20	3.1	7.7
31	652	246	162	62	75	185	306	0	940	520	44.7	6	2.82	59	19	5.2	8.2
Sept. 1	-	-	-	-	-	-	-	-	-	352	-	-	-	-	19	8.0	8.3
2	-	43	12	-	-	17	187	0	236	266	0	10	1.76	-	19	7.8	8.3
3	164	93	26	43	84	86	148	0	171	221	0	10	1.76	24	20	7.3	8.2
4	-	40	37	-	-	276	194	30	465	321	30.9	9	1.92	-	19	6.7	8.1
5	244	80	46	67	81	109	180	0	303	210	30.7	13	1.32	46	17	7.1	8.1
6	480	139	45	71	91	233	225	3.4	492	335	31.5	17	1.02	115	21	5.8	8.2
7	228	133	60	42	73	689	271	61	540	530	1.8	15	1.15	48	21	5.6	9.5
8	228	155	34	32	85	165	224	0	210	245	0	5	3.59	16	21	7.9	8.8
9	127	63	28	51	78	256	111	57	218	211	3.3	14	1.23	26	21	8.0	10.5
10	257	-	-	-	-	378	176	53.5	835	410	50.9	10	1.76	37	20	7.3	9.6
11	148	66	20	55	87	218	128	41	575	287	50.1	10	1.76	22	20	7.2	8.5
12	220	70	29	68	87	200	173	13.5	617	204	67.1	10	1.76	31	20	6.8	8.3
13	-	-	-	-	-	393	208	47	218	-	-	10	1.76	-	15	8.1	9.8

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM MIXT.	BOD EFFLUENT PPM SUPER.	BOD % REDUCTION MIXT.	BOD % REDUCTION SUPER.	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	RETENTION DAYS	LOAD LB. BOD PER DAY	TEMP °C	DO PPM	PH
Sept. 14	144	175	33	0	77	138	198	0	190	215	0	10	1.76	21	15	8.4	9.3
15	206	140	60	32	71	253	249	1.6	695	310	55.3	10	1.76	29	18	7.9	8.7
16	127	58	32	54	75	-	222	-	192	230	0	10	1.76	19	18	8.1	8.7
17	305	118	20	61	94	266	197	26	509	231	74.3	10	1.76	44	19	7.7	8.9
18	-	-	-	-	-	-	-	-	-	-	-	10	-	-	19	7.4	8.3
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	357	24	34	93	91	186	167	11	726	208	71.4	15	1.14	77	19	7.5	8.9
21	225	50	30	78	87	152	174	0	313	198	36.7	15	1.14	48	17	7.7	8.8
22	-	-	-	-	-	-	-	-	-	188	-	-	-	-	16	7.4	8.6
23	206	84	45	59	78	114	151	0	473	212	55.2	18	0.97	53	15	9.0	-
24	238	116	68	51	71	86	118	0	543	199	63.4	20	0.87	73	15	8.3	-
25	125	100	45	20	64	93	126	0	240	205	6.3	20	0.87	38	17	7.1	-
26	350	72	35	80	90	284	177	37.5	524	170	67.5	20	0.87	101	18	7.4	8.9
27	258	34	20	87	93	199	182	8.6	631	224	63.6	25	0.70	94	18	7.6	8.7
28	564	38	21	93	97	167	179	0	835	224	73.2	25	0.70	202	18	6.8	8.3
29	172	104	54	39	69	343	180	48	346	248	28.3	20	0.87	49	17	7.5	8.3
30	822	86	15	90	97	119	150	-	1025	212	79.2	20	0.87	238	15	8.3	8.3
Oct. 1	490	-	-	-	-	130	117	10	685	286	58.3	20	0.87	141	18	6.1	8.3
2	468	80	31	83	93	111	115	0	551	220	60.1	20	0.87	136	17	6.8	8.6
3	1184	111	61	91	95	180	146	18.9	1240	274	77.9	20	0.87	350	17	6.9	8.3
4	448	79	80	82	82.1	322	210	35	518	-	-	20	0.87	130	18	6.3	8.5
5	496	160	80	67.8	84	274	242	11.6	651	580	10.9	15	1.14	106	18	3.8	8.1
6	-	-	-	-	-	-	-	-	-	565	-	-	-	-	18	4.6	8.2
7	600	146	61	92	90	208	160	23	792	290	63.4	30	0.57	259	16	7.5	8.2
8	1060	200	100	81.1	90.5	343	432	0	1670	740	54.7	20	0.87	315	17	0.6	7.5

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM MIXT.	BOD EFFLUENT PPM SUPER.	BOD % REDUCTION MIXT.	BOD % REDUCTION SUPER.	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	RETENTION DAYS	LOAD LB. BOD PER DAY	TEMP °C	DO PPM	PH
Oct. 9	1312	200	100	85	92	269	379	0	1390	308	78	0	-	0	15	4.0	7.2
10	568	221	60	61	89	618	282	54	527	575	0	0	-	0	16	7.6	8.2
11	900	100	100	89	89	366	253	31	1370	505	63	0	-	0	15	8.5	8.3
12	640	89	89	86	86	394	352	11	692	678	2	20	0.87	186	16	4.0	8.7
13	-	-	-	-	-	-	-	-	-	605	-	0	-	0	17	8.0	8.6
14	-	-	-	-	-	-	-	-	-	642	-	0	-	0	14	7.4	8.3
15	536	296	170	45	68	135	327	0	532	532	0	29	0.57	232	12	8.6	8.2
16	1460	387	76	73	95	406	316	22	1570	810	48	22	0.79	480	14	4.0	8.2
17	140	329	150	0	0	89	366	0	266	749	0	20	0.87	49	16	2.5	8.8
18	508	265	128	48	75	889	320	64	918	445	52	25	0.70	183	14	5.6	9.0

TABLE 13A

BOD REMOVAL CALCULATIONS

LAGOON #3 - TOMATO PACK PERFORMANCE

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM		LAGOON BOD-LB	BOD - POUNDS PER DAY			DISS.O_2 CONC.-PPM
				INFLUENT	EFFLUENT		INFLUENT	EFFLUENT	BIO-REMOVAL	
Aug. 27	90	21,900	797	206	70	15.3	30	4.3	11.4	8.4
28	90	"	"	544	135	29.6	66	15.5	5.3	7.0
29	90	"	"	668	341	74.8	94	49.1	65.6	1.0
30	90	"	"	640	247	54.1	58	21.3	36.9	3.1
31	90	"	"	652	246	53.9	59	21.2	(60.1)	5.2
Sept. 1	90	"	"	-	-	-	0	4.3	(18.0)	8.0
2	89½	21,600	790	(125)	43	9.3	(17)	6.1	(- 0.2)	7.8
3	90	21,900	797	164	93	20.4	24	13.4	22.2	7.3
4	90	21,900	797	(200)	40	8.8	(26)	5.2	11.9	6.7
5	90½	22,100	802	244	80	17.7	46	15.0	18.0	7.1
6	90½	22,100	802	480	139	30.7	115	33.8	82.2	5.8
7	91	22,300	808	228	133	29.7	48	28.8	14.3	5.6
8	91	22,300	808	228	155	34.6	16	15.6	21.2	7.9
9	90	21,900	797	127	63	13.8	26	12.9	(12.7)	8.0
10	89½	21,600	790	257	-	-	37	12.7	(23.9)	7.3
11	90	21,900	797	148	66	14.5	22	9.5	11.7	7.2
12	90	"	"	220	70	15.3	31	10.1	(9.4)	6.8
13	90	"	"	(200)	-	-	(29)	17.7	((0.2))	8.1
14	90	"	"	144	175	38.3	21	25.7	3.4	8.4
15	89½	21,600	790	206	140	30.2	29	19.7	26.8	7.9
16	90	21,900	797	127	58	12.7	19	8.2	- 2.4	8.1

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS.O_2 CONC.-PPM
Sept.17	90	21,900	797	305	118	25.9	44	16.6	(34.3)	7.7
18	90	"	"	-	-	-	0	20.3	(- 13.4)	-
19	-	-	-	-	-	-	0	0.0	(- 6.9)	-
20	90	21,900	797	357	24	5.3	77	5.3	66.2	7.5
21	89½	21,600	790	225	50	10.8	48	10.7	(33.5)	7.7
22	90	21,900	797	147	-	-	32	0.0	(28.2)	7.4
23	90	"	"	206	84	18.4	53	21.9	24.1	9.0
24	90	"	"	238	116	25.4	73	32.8	42.9	8.3
25	92	22,700	819	125	100	22.7	38	29.2	15.4	7.1
26	91	22,300	808	350	72	16.1	101	20.7	88.8	7.4
27	91	"	"	258	34	7.6	94	12.2	80.9	7.6
28	91	"	"	564	38	8.5	202	13.7	173.6	6.8
29	91	"	"	172	104	23.2	49	30.0	23.0	7.5
30	91	"	"	822	86	19.2	238	24.6	(212.3)	8.3
Oct. 1	91½	22,500	813	490	(90)	(20.3)	141	26.1	(117.3)	6.1
2	91	22,300	808	468	80	17.9	136	23.0	106.1	6.8
3	91	"	"	1184	111	24.8	350	32.0	325.2	6.9
4	91	"	"	448	79	17.6	130	22.8	89.1	6.3
5	91	"	"	496	160	35.7	106	34.5	(73.8)	3.8
6	91	"	"	-	(150)	(33.4)	(183)	32.4	(151.4)	4.6
7	91	"	"	600	146	32.6	259	63.0	184.0	7.5
8	91	"	"	1060	200	44.6	315	57.6	257.4	0.6
9	91	"	"	-	200	44.6	0	1.6	- 4.3	4.0
10	89	21,400	784	-	221	47.3	0	0.8	27.1	7.6
11	88	21,000	772	-	100	21.0	0	0.0	2.0	8.5

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS. O_2 CONC.-PPM
Oct. 12	89	21,400	790	640	89	19.0	186	25.9	(149.2)	4.0
13	87	20,600	760	-	(145)	(29.9)	0	1.3	(- 16.0)	8.0
14	85	19,900	739	-	-	-	0	0.0	(- 14.7)	7.4
15	85½	20,000	744	536	296	59.2	232	121.8	84.6	8.6
16	90	21,900	797	1460	387	84.8	480	122.7	370.1	4.0
17	90	"	"	140	329	72.0	49	94.7	- 31.7	2.5
18	90	"	"	508	265	58.0	183	95.9	89.8	5.6
AVERAGE	90	21,890	797	400	135	29.3	177.5	25.4	60.6	6.62

APPENDIX A

TABLE 14

RESULTS OF MECHANICALLY AERATED LAGOON (#3) AFTER TOMATO PACK

DATE 1963	BOD MIXTURE PPM	BOD SUPER-NATANT PPM	COD MIXTURE PPM	SUSP. SOLIDS PPM	TEMP. °C	PH	DO DAY PPM
Oct. 19	250	120	483	245	18	8.3	7.4
20	255	100	632	194	15	8.3	7.8
21	55	28	330	209	14	8.2	8.3
22	155	76	321	227	13	8.4	9.4
23	120	58	325	207	13	8.5	7.4
24	110	52	315	205	14	8.6	7.8
25	165	82	292	220	14	8.3	8.0
26	94	49	285	219	14	8.1	8.4
27	61	32	272	199	13	8.2	8.4
28	88	20	256	262	11	8.3	7.2
29		12	124	35	10	8.2	7.0
30		12	100	33	10	8.1	6.2
31		14	116	39	10	8.0	5.6
Nov. 1		18	96	38	9	7.9	5.0
2					8	7.8	4.4
3					7	7.7	3.2
4					7	7.7	3.0
5					7	7.8	4.4
6					10	8.2	3.8

TABLE 14A

BOD REMOVAL CALCULATIONS

LAGOON #3 - PERFORMANCE FOLLOWING TOMATO PACK

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY EFFLUENT	BOD - POUNDS PER DAY BIO-REMOVAL	DISS.O_2 CONC.-PPM	REMARKS
							89.8		
Oct. 19	90½	22,100	802	250	55.3	1.2	- 1.8	7.4	AVERAGE VOLUME LOSS
20	90	21,900	797	255	55.9	"	43.2	7.8	600 GALLONS/DAY
21	88	21,000	773	55	11.5	"	- 21.0	8.3	
22	86	20,200	750	155	31.3	-	-	9.4	
23	-	-	-	120	-	-	-	7.4	
24	-	-	-	110	-	-	-	7.8	
25	-	-	-	165	-	-	-	8.0	
26	-	-	-	94	-	-	-	8.4	
27	-	-	-	61	-	-	-	8.4	
28	-	(20,000)	-	88	(43.0)	-	-	7.2	
AVERAGE 19/10 to 22/10	88½	21,300	(775)	178	38.5	(1.2)	(27.6)	8.2	

APPENDIX A

TABLE 15

RESULTS OF WASTE STABILIZATION POND #4 DURING PEA PACK

NOTE: INFLUENT TO NO. 4 LAGOON IS LAGOON #3 EFFLUENT

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION PPM UNFILT	BOD REDUCTION PPM FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH
June 24	-	140	-	-	-	-	152	-	-	138	-	0	0	0	27	0.0	10.0	8.0
25	800	170	-	79	-	522	122	77	1012	260	74.3	4	48	1200	27	0.0	0.2	7.2
26	312	156	-	50	-	356	117	67	664	382	42.4	5	23	575	25	0.6	0.2	7.3
27	248	152	-	38.5	-	260	75	71	520	314	39.6	7.5	27	675	25	0.0	0	7.3
28	228	74	-	67.5	-	235	73	69	483	386	20.1	7.5	25	625	27	0.0	0	7.5
29	380	112	-	71	-	244	142	42	406	447	0	7.5	42	1050	26	0.0	3.0	7.6
30	206	120	-	42	-	281	154	45	456	384	15.8	7.5	23	575	27	0.0	0.7	7.7
July 1	-	68	-	-	-	-	103	-	-	280	-	3.8	-	-	27	0.0	0	7.5
2	-	32	-	-	-	-	79	-	-	240	-	0	0	0	28	2.2	0.2	7.8
3	-	118	-	-	-	-	114	-	-	240	-	0	0	0	26	0.0	0	7.9
4	-	89	-	-	-	-	105	-	-	245	-	0	0	0	23	0.0	0	7.8
5	-	67	-	-	-	-	229	-	-	231	-	0	0	0	23	0.0	0	8.0
6	-	189	-	-	-	-	-	-	-	212	-	0	0	0	23	0.0	5.5	8.0
7	-	146	-	-	-	-	21	-	-	214	-	0	0	0	22	0.2	0.9	8.0
8	-	53	-	-	-	-	86	-	-	280	-	0	0	0	21	0.0	0	7.9
9	-	65	-	-	-	-	223	-	-	518	-	0	0	0	20	0.0	0	7.8
10	-	83	-	-	-	-	39	-	-	-	-	0	0	0	21	0.0	5.6	8.2
11	-	59	-	-	-	-	156	-	-	366	-	0	0	0	21	0.0	2.7	8.5
12	-	95	38	-	-	-	125	-	-	327	-	0	0	0	21	0.2	4.9	8.7
13	-	146	54	-	-	-	109	-	-	358	-	0	0	0	22	0.0	1.1	8.5

DATE 1963	BOD					SUSPENDED SOLIDS			COD			FEED	BOD LOADING		TEMP	DO		PH
	INFL PPM	EFFLUENT PPM UNFILT	FILT	REDUCTION PPM UNFILT	FILT	INFL PPM	EFFL PPM	RED %	INFL PPM	EFFL PPM	RED %	IGPM	LB/DAY	LB/DAY/ ACRE	°C	NIGHT PPM	DAY PPM	
July 14	-	40	30	-	-	-	87	-	-	243	-	0	0	0	22	0.1	0.5	8.4
15	-	179	94	-	-	-	74	-	-	246	-	0	0	0	19	0.0	1.4	8.3
16	-	54	38	-	-	-	48	-	-	254	-	0	0	0	22	1.2	2.5	7.9
17	-	79	57	-	-	-	41	-	-	241	-	0	0	0	22	8.3	4.2	8.3
18	185	94	50	49	73	337	12	97	384	291	24.2	1.0	2	50	23	1.1	1.6	9.1
19	104	41	20	60.5	81	280	-	-	330	237	28.2	1.0	1	25	24	1.2	0.5	9.0
20	99	67	38	32.5	61.5	262	82	69	345	310	10.1	1.0	1.5	37.5	23	1.0	1.7	9.0
21	119	-	37	-	69	625	111	82.5	304	280	7.9	1.1	2	50	23	1.0	7.5	9.0
22	218	91	69	58	68.5	264	66	75	434	278	36	1.1	2	50	24	2.4	4.5	9.4
23	103	126	39	-	62	229	278	0	321	420	0	1.1	1	25	24	0.6	2.7	-
24	130	68	27	47.5	79.5	238	168	29.2	331	312	5.8	1.0	2	50	25	2.1	1.9	9.0
25	145	51	32	65	78	194	148	24	418	273	34.7	1.0	2.2	55	25	11.3	3.7	9.0
26	132	104	29	21.2	78	348	244	30	412	431	0	1.0	2	50	25	3.1	4.6	10.0
27	92	51	20	44.5	78	244	38	84	925	249	73.1	1.0	1.4	35	25	2.3	5.6	9.6
28	87	76	14	12.6	84	333	71	79	684	272	60.2	1.0	1.1	27.5	26	2.2	1.4	9.6
29	74	-	-	-	-	25	72	0	125	194	0	1.0	1.1	27.5	25	1.5	0.4	9.0
30	118	99	27	16	77	656	105	84	484	219	54.7	8.0	14.4	360	24	3.1	2.0	9.4
31	-	59	27	-	-	-	141	-	430	238	44.7	0	0	0	24	-	1.4	9.3

TABLE 15A

BOD REMOVAL CALCULATIONS

LAGOON #4 - PEA PACK PERFORMANCE

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS. O_2 CONC.-PPM	REMARKS
June 24	15	7,800	798	0	140	10.9	0.0	4.9	- 8.5	6.6	
25	16	8,500	808	800	170	14.5	46.1	"	40.1	0.04	
26	18	10,000	825	312	156	15.6	22.5	"	- 10.3	0.1	AVERAGE VOLUME LOSS
27	37	28,600	1,060	248	152	43.5	26.8	"	39.4	0.0	3,710 GALLONS/DAY
28	42	35,200	1,150	228	74	26.0	24.6	"	3.1	0.0	
29	44	38,000	1,182	380	112	42.6	41.0	"	33.1	1.0	
30	44	38,000	1,182	206	120	45.6	22.2	"	37.1	0.4	
July 1	44	38,000	1,182	-	68	25.8	0	1.5	12.1	0.0	
2	44	38,000	1,182	-	32	12.2	0	"	- 33.7	0.8	
3	44	38,000	1,182	-	118	44.4	0	"	13.9	0.0	AVERAGE VOLUME LOSS
4	40	32,600	1,115	-	89	29.0	0	"	5.7	0.0	1,510 GALLONS/DAY
5	40	32,600	1,115	-	67	21.8	0	"	- 38.7	0.0	
6	39	31,200	1,100	-	189	59.0	0	"	12.9	1.8	
7	39	31,200	1,100	-	146	44.6	0	"	28.6	0.5	
8	36	27,400	1,050	-	53	14.5	0	0.5	- 3.8	0.0	
9	36	27,400	1,050	-	65	17.8	0	"	- 5.4	0.0	
10	36	27,400	1,050	-	83	22.7	0	"	6.0	1.9	AVERAGE VOLUME LOSS
11	36	27,400	1,050	-	59	16.2	0	"	- 10.5	1.4	660 GALLONS/DAY
12	36	27,400	1,050	-	95	26.0	0	"	- 11.0	1.7	
13	34	25,000	1,020	-	146	36.5	0	"	26.7	0.4	
14	32½	23,200	1,000	-	40	9.3	0	"	- 32.0	0.2	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS.O_2 CONC.-PPM	REMARKS
July 15	32	22,800	992	-	179	40.8	0	0.8	27.1	0.5	
16	33	23,800	1,007	-	54	12.9	0	"	- 4.3	1.9	
17	30	20,700	965	-	79	16.4	0	"	- 3.9	5.8	AVERAGE VOLUME LOSS
18	30	20,700	965	185	94	19.5	2.7	"	12.9	1.4	1,000 GALLONS/DAY
19	30	20,700	965	104	41	8.5	1.5	"	- 4.7	0.7	
20	30	20,700	965	99	67	13.9	1.4	"	- 2.3	1.3	
21	30	20,700	965	119	-	(16.8)	1.9	"	- 1.8	3.0	
22	31	21,700	978	218	91	19.7	3.5	0.7	- 4.8	7.6	
23	31	21,700	978	103	126	27.3	1.6	"	13.4	2.8	
24	31	21,700	978	130	68	14.8	1.9	"	4.9	2.0	AVERAGE VOLUME LOSS
25	31	21,700	978	145	51	11.1	2.1	"	- 13.5	7.5	840 GALLONS/DAY
26	34	25,000	1,020	132	104	26.0	1.9	"	14.4	3.1	
27	34	25,000	1,020	92	51	12.8	1.3	"	- 7.4	2.2	
28	36	27,400	1,050	87	76	20.8	1.3	"	- 2.5	2.0	
29	35	26,200	1,035	74	-	(23.9)	1.1	4.0	- 6.1	0.9	AVERAGE VOLUME LOSS
30	36	27,400	1,050	118	99	27.1	13.6	"	20.5	1.7	7,040 GALLONS/DAY
31	36	27,400	1,050	0	59	16.2	0.0	"		0.9	
AVERAGE	34¼	26,000	1,032	99.5	94.8	23.9	5.76	1.86	3.96	1.63	

APPENDIX A

TABLE 16

RESULTS OF WASTE STABILIZATION POND #4 BETWEEN PEA AND TOMATO PACK

DATE 1963	BOD UNFILT PPM	BOD FILT PPM	COD PPM	SUSP. SOLIDS PPM	TEMP °C	PH	D.O DAY PPM
Aug.1	49	40	221	65	23	8.8	2.1
2	69	24	272	142	23	8.8	1.9
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	58	44	302	130	21	9.3	1.4
6	67	38	433	278	23	9.5	1.5
7	113	29	295	189	23	9.5	1.3
8	108	49	344	245	23	9.5	2.4
9	77	42	198	189	22	9.5	1.3
10	-	-	-	-	23	8.6	1.6
11	-	-	-	-	23	7.9	2.0
12	24	18	129	33	23	7.7	1.2
13	12	10	125	30	22	7.7	1.5
14	17	15	128	54	20	7.6	0.8
15	21	12	117	-	19	7.6	1.4
16	27	14	120	39	20	7.6	1.8
17	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-
19	43	23	128	49	19	7.6	2.6
20	28	25	120	43	19	7.9	7.2
21	25	9	185	96	20	8.7	20.0
22	26	10	176	168	-	-	-
23	43	33	175	102	24	10.8	14.0

TABLE 16A

BOD REMOVAL CALCULATIONS

LAGOON #4 - PERFORMANCE BETWEEN PEA AND TOMATO PACKS

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT²	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS. O_2 -PPM	REMARKS
Aug. 1	36	27,200	1,050	-	49	13.3	0	0.65	-6.2	1.4	
2	36	27,200	1,050	-	69	18.8	0	"	(-1.6)	1.3	
3	-	-	-	-	-	-	0	"	(-1.6)	-	
4	-	-	-	-	-	-	0	"	(-1.6)	-	AVERAGE VOLUME LOSS
5	-	-	-	-	58	-	0	"	(-1.6)	1.4	914 GALLONS/DAY
6	-	-	-	-	67	-	0	"	(-1.6)	1.4	
7	31	20,800	978	-	113	23.5	0	"	0.3	1.3	
8	31	20,800	978	-	108	22.5	0	0.74	-0.2	1.3	
9	37	28,500	965	Small	77	22.0	Negl.	"	(3.7)	1.3	* INCREASES DUE TO
10	44	38,000*	1,182	"	-	-	"	"	(3.7)	1.6	ADDITION OF CITY WATER
11	44	38,000*	1,182	"	-	-	"	"	(3.7)	1.9	
12	43	36,600*	1,165	-	24	8.8	0	"	3.7	1.2	ESTIMATED VOLUME LOSS 1,545
13	43	36,600	1,165	-	12	4.4	0	"	-1.7	1.5	GALLONS/DAY
14	41	34,000	1,131	-	17	5.4	0	"	-1.7	0.9	ACTUAL GAIN 9,800 GALLONS
15	39	30,600	1,100	-	21	6.4	0	0.66	-2.4	1.3	
16	38	30,000	1,081	-	27	8.1	0	"	(-1.9)	1.7	
17	-	-	-	-	-	-	0	"	(-1.9)	-	
18	-	-	-	-	-	-	0	"	(-1.9)	-	AVERAGE VOLUME LOSS
19	36	27,200	1,050	-	43	11.7	0	"	3.4	2.6	2,185 GALLONS/DAY
20	36	27,200	1,050	-	28	7.6	0	"	0.1	7.3	
21	36	27,200	1,050	90	25	6.8	6.5	"	(3.4)	20.2	

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS. O_2 -PPM	REMARKS
Aug. 22	-	-	-	79	26	-	6.2	0.66	(3.1)	-)	
23	36	27,200	1,050	75	43	11.7	1.1	"		13.6)	
AVERAGE	38	29,800	1,077	81.3	47.5	12.2	0.060	0.68	+ 0.068	3.46	

APPENDIX A

TABLE 17

RESULTS OF WASTE STABILIZATION POND #4 DURING TOMATO PACK

NOTE: INFLUENT TO NO. 4 LAGOON IS LAGOON #3 EFFLUENT

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION PPM UNFILT	BOD REDUCTION PPM FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH
Aug. 21	90	25	9	72	90	220	96	57	-	128	-	3	6.3	158	20	-	20	8.7
22	79	26	10	67	87	139	168	0	-	120	-	-	5.4	135	-	-	-	-
23	75	43	33	43	56	134	102	24	-	185	-	-	1.1	27.5	24	-	14	10.8
27	70	32	20	54.5	71.5	139	38	73	149	171	0	0.5	1.1	27.5	20	0.0	0.0	9.9
28	-	48	32	-	-	-	83	-	233	164	29.6	0	0	0	20	0.4	0.5	9.9
29	-	30	17	-	-	-	47	-	655	164	75.4	0	0	0	19	0.9	0.7	9.8
30	-	35	28	-	-	-	67	-	583	186	68.2	0	0	0	20	5.3	5.0	9.9
31	-	45	18	-	-	-	59	-	520	218	58.1	0	0	0	20	7.8	8.0	9.8
Sept. 1	-	30	16	-	-	-	78	-	352	157	55.4	0	0	0	25	-	20.3	9.8
2	43	27	10	37	77	187	64	66	266	143	46.2	1.2	7.0	175	20	13.1	13.5	9.9
3	93	20	13	79	86	148	102	31	221	135	38.9	1	1.4	40	21	7.7	5.2	9.7
4	-	-	10	-	-	-	27	-	321	121	62.3	-	-	-	19	3.8	5.6	9.5
5	80	42	21	47.5	74	180	17	91	210	128	39	2	2.4	60	18	3.7	9.5	9.5
6	139	29	23	79	91	225	17	93	335	169	49.6	2	4.0	100	20	9.9	17.4	9.7
7	133	31	22	77	84	271	23	92	530	164	69.1	1	2.0	50	19	12.0	13.3	9.7
8	155	32	22	80	86	224	33	85	245	152	38	1	2.3	57.5	19	9.6	11.9	9.5
9	63	35	28	44.5	55.5	111	48	57	211	146	30.7	1	0.95	23.8	22	9.7	9.7	9.7
10	-	-	24	-	-	176	110	37.5	410	465	0	1	-	-	19	9.6	9.5	9.6
11	66	15	19	78	71	128	78	39	287	406	0	1	1.0	25	20	9.4	-	9.4
12	70	35	23	50	66	173	51	71	204	175	14.2	1	1.1	27.5	20	9.4	9.4	9.4

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION PPM UNFILT	BOD REDUCTION PPM FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH
Sept.13	-	-	-	-	-	208	79	62	-	164	-	2	-	-	13	2.3	4.4	9.4
14	175	39	39	78	83	198	98	51	215	205	4.7	1	2.7	67.5	14	4.1	8.9	9.3
15	140	50	50	64	61.5	249	54	78	310	174	43.8	2	4.0	100	16	7.4	9.8	9.1
16	58	47	29	19	50	222	62	72.5	230	156	32.1	2	1.7	42.5	18	8.2	11.0	9.2
17	118	42	27	64	77	197	37	81.5	231	161	30.3	2	4	100	19	9.7	10.6	9.1
18	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
20	24	37	26	0	0	167	35	79	208	135	35.1	4	1.5	37.5	19	4.2	4.1	8.7
21	50	38	23	24	54	174	67	61.5	198	148	25.3	4	2.9	47.5	17	3.7	3.5	8.7
22	88	30	21	66	76	117	36	69	188	131	30.3	4	5.3	132.5	16	4.0	4.4	8.6
23	84	29	24	66	71.5	151	58	62	212	131	38.2	4	5.0	125	15	1.6	2.7	-
24	-	39	25	-	-	-	25	-	-	114	-	0	0	0	15	0.5	1.4	-
25	-	23	26	-	-	-	24	-	-	116	-	0	0	0	17	0.9	1.7	-
26	-	39	30	-	-	-	37	-	-	103	-	0	0	0	18	2.1	2.9	-
27	34	23	18	32.5	47	182	40	78	224	124	44.7	2	1.0	25	18	4.0	5.8	8.5
28	38	35	20	7.9	47.5	179	79	56	224	150	33	2	1.0	25	18	4.3	5.3	8.6
29	104	23	17	78	84	180	39	78	248	110	55.7	2	3.0	75	17	6.3	6.9	8.6
30	86	22	18	75	79	150	64	57.5	212	118	44.3	2	2.5	62.5	15	5.5	6.5	8.6
Oct. 1	-	23	22	-	-	117	84	28	286	165	42.4	4	-	-	18	9.4	9.2	8.7
2	80	-	-	-	-	115	58	49.5	220	161	26.8	4	4.7	117.5	17	10.7	9.7	8.7
3	111	40	30	64	73	146	69	53	274	180	34.3	2	4.0	100	17	8.4	8.7	8.6
4	79	72	80	8.9	0	210	33	84	-	106	-	3	3.2	80	18	6.3	6.5	8.5
5	160	36	36	77.5	77.5	242	21	92	580	94	83.8	2	5.0	125	18	9.0	5.8	8.4
6	80	39	23	51	71	46	15	68	565	90	82	1	1.2	30	18	-	6.9	8.5
7	146	28	13	81	91	160	41	75	290	178	38.6	5	11	275	16	4.9	4.9	8.6

DATE 1963	BOD INFL PPM	BOD EFFLUENT PPM UNFILT	BOD EFFLUENT PPM FILT	BOD REDUCTION PPM UNFILT	BOD REDUCTION PPM FILT	SUSPENDED SOLIDS INFL PPM	SUSPENDED SOLIDS EFFL PPM	SUSPENDED SOLIDS RED %	COD INFL PPM	COD EFFL PPM	COD RED %	FEED IGPM	BOD LOADING LB/DAY	BOD LOADING LB/DAY/ ACRE	TEMP °C	DO NIGHT PPM	DO DAY PPM	PH
Oct. 8	200	36	32	82	84	432	49	89	740	88	88.1	1	3	75	17	1.4	3.4	7.8
9	-	30	24	-	-	-	20	-	-	94	-	0	0	0	15	-	2.8	7.9
10	-	24	14	-	-	-	31	-	-	47	-	0	0	0	16	5.7	7.2	8.4
11	-	19	10	-	-	-	56	-	-	110	-	0	0	0	16	8.0	5.9	8.3
12	89	81	82	8.9	7.8	352	76	78	678	94	86.2	1	1.3	32.5	15	3.9	3.2	8.3
13	215	23	17	89	92	367	44	88	605	91	85	1	3.5	87.5	14	-	4.4	8.4
14	250	24	16	90	94	279	72	74.5	642	118	81.8	1	3.8	95	14	-	5.2	8.4
15	296	27	11	91	97	327	46	86	532	118	77.9	3	12	300	14	8.4	1.6	8.2
16	387	41	30	89.5	92	316	50	84	810	129	84.1	3	19	475	14	8.4	6.6	8.3
17	329	29	19	91	94	366	29	92	749	136	82	2	9	225	14	8.9	8.0	8.3
18	265	32	24	88	91	320	82	75	445	140	68.5	3	11	275	13	5.0	6.6	8.1

TABLE 17A

BOD REMOVAL CALCULATIONS

LAGOON #4 - TOMATO PACK PERFORMANCE

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS. O_2 CONC.-PPM	REMARKS
Aug. 27	36	27,400	1,050	70	32	8.8	1.01	0.22	-3.8	0.0	
28	36	27,400	1,050	-	48	13.4	0	"	5.7	0.4	
29	34	25,000	1,020	-	30	7.5	0	"	-1.5	0.8	AVERAGE VOLUME LOSS
30	35	26,200	1,036	-	35	8.8	0	"	-2.6	5.1	624 GALLONS PER DAY
31	35	26,200	1,036	-	45	11.2	0	"	3.2	7.9	
Sept. 1	35	26,200	1,036	-	30	7.8	0	"	0.8	20.1	
2	34½	25,600	1,028	43	27	6.8	0.74	"	2.1	13.3	
3	35	26,200	1,036	93	20	5.2	1.34	0.46	(-2.7)	6.5	
4	35	26,200	1,036	-	-	-	0	"	(-2.7)	6.3	
5	35	26,200	1,036	80	42	11.0	2.30	"	5.2	6.6	AVERAGE VOLUME LOSS
6	35	26,200	1,036	134	29	7.6	3.86	"	2.5	13.8	1,470 GALLONS PER DAY
7	36	27,400	1,050	133	31	8.5	1.92	"	1.1	12.7	
8	36	27,400	1,050	155	32	8.8	2.23	"	0.9	10.7	
9	36	27,400	1,050	63	35	9.6	0.91	"	(3.8)	9.0	
10	36	27,400	1,050	(170)	-	-	(2.44)	0.76	(3.8)	4.6	
11	36	27,400	1,050	66	15	4.1	0.95	"	-5.4	2.7	
12	36	27,400	1,050	70	35	9.6	1.01	"	(-0.7)	2.8	AVERAGE VOLUME LOSS
13	35½	27,400	1,050	-	-	-	0	"	(-0.7)	3.3	2,050 GALLONS PER DAY
14	35½	26,800	1,042	175	39	10.5	2.52	"	-1.2	6.5	
15	35½	26,800	1,042	140	50	13.4	4.03	"	4.0	8.6	
16	36	27,400	1,050	58	47	12.6	1.67	"	2.2	9.6	

DATE 1963		LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO REMOVAL	DISS. O_2 CONC.-PPM	REMARKS
Sept.	17	36	27,400	1,050	118	42	11.3	3.40	2.02	(-0.8)	10.2	
	18	36	27,400	1,050	-	-	-	0	"	(-0.8)	9.2	
	19	(37)	(28,300)	(1,066)	-	-	-	0	"	(-0.8)	-	AVERAGE VOLUME LOSS
	20	38	30,000	1,082	24	37	11.1	1.38	"	-3.1	4.1	5,790 GALLONS PER DAY
	21	43	36,600	1,166	50	38	13.6	2.88	"	3.5	3.6	
	22	43	36,600	1,166	88	30	11.0	5.07	"	3.3	4.2	
	23	43½	37,300	1,174	84	29	10.8	4.84	"	-0.7	2.1	
	24	43	36,600	1,166	-	39	14.3	0	0.48	5.4	0.9	
	25	43	36,600	1,166	-	23	8.4	0	"	-6.4	1.3	
	26	43	36,600	1,166	-	39	14.3	0	"	5.0	2.5	AVERAGE VOLUME LOSS
	27	43	36,600	1,166	34	23	8.8	0.98	"	-3.5	4.8	1,640 GALLONS PER DAY
	28	43	36,600	1,166	38	35	12.8	1.09	"	5.0	4.8	
	29	43	36,600	1,166	104	23	8.4	2.99	"	2.8	6.6	
	30	43	36,600	1,166	86	22	8.1	2.48	"	1.7	6.0	
Oct.	1	43	36,600	1,166	(125)	23	8.4	(7.2)	1.72	(1.3)	9.3	
	2	42	35,200	1,150	80	-	-	4.68	"	(1.3)	10.2	
	3	42½	35,900	1,158	111	40	14.3	3.20	"	-10.6	8.6	AVERAGE VOLUME LOSS
	4	43	36,600	1,166	79	72	26.4	3.11	"	14.6	6.1	4,320 GALLONS PER DAY
	5	43	36,600	1,166	160	36	13.2	4.61	"	1.8	6.6	
	6	43	36,600	1,166	80	39	14.3	1.15	"	3.6	6.9	
	7	43	36,600	1,166	146	28	10.2	10.51	"	5.8	4.9	
	8	43	36,600	1,166	200	36	13.2	2.88	0.61	4.5	2.4	
	9	43	36,600	1,166	-	30	11.0	0	"	1.8	2.8	
	10	42½	35,900	1,158	-	24	8.6	0	"	1.3	6.6	AVERAGE VOLUME LOSS

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD - PPM INFLUENT	BOD - PPM EFFLUENT	LAGOON BOD-LB.	BOD - POUNDS PER DAY INFLUENT	BOD - POUNDS PER DAY EFFLUENT	BIO-REMOVAL	DISS. O_2 CONC.-PPM	REMARKS
Oct. 11	42	35,200	1,150	-	19	6.7	0	0.61	-22.4	6.8	1,850 GALLONS PER DAY
12	42	35,200	1,150	89	81	26.5	1.17	"	21.0	2.9	
13	42	35,200	1,150	215	23	8.1	0.33	"	-0.3	4.3	
14	41	33,900	1,133	250	24	8.1	0.35	"	0	5.2	
15	37½	29,300	1,074	296	27	7.9	1.17	1.03	-4.2	8.3	
16	38	29,900	1,082	387	41	12.2	1.71	"	4.0	8.8	AVERAGE VOLUME LOSS
17	38½	30,600	1,090	329	29	8.9	0.66	"	-1.4	5.9	3,200 GALLONS PER DAY
18	39	31,200	1,012	265	32	10.0	1.38	0.71	-1.5	5.7	
						12.2					
AVERAGES	39	31,400	1,100	129	39.6	10.8	1.81	0.90	0.854	6.5	

APPENDIX A

TABLE 18

RESULTS OF WASTE STABILIZATION POND #4 AFTER THE TOMATO PACK

DATE 1963	BOD UNFILT PPM	BOD FILT PPM	COD PPM	SUSP. SOLIDS PPM	TEMP °C	PH	D.O DAY PPM
Oct.19	38	26	148	45	17	8.2	4.0
20	29	23	133	43	15	8.1	3.3
21	19	8	123	64	14	7.9	3.3
22	22	11	126	69	15	8.0	-
23	21	9	119	90	14	8.3	6.2
24	25	13	138	102	14	8.5	7.0
25	44	19	156	109	15	8.7	9.5
26	41	15	152	116	15	9.2	10.8
27	46	23	152	126	14	8.9	10.2
28	37	15	176	150	13	8.4	8.1
29	40	11	180	142	11	8.1	5.5
30	37	13	200	142	11	8.5	10.1
Oct.31	33	16	220	115	10	8.2	8.6
Nov. 1	20	9	200	140	9	8.1	6.9
2	-	-	-	-	7	8.2	7.5
3	-	-	-	-	6	8.3	8.1
4	-	-	-	-	6	8.3	7.1
5	-	-	-	-	7	8.6	12.2
Nov. 6	-	-	-	-	9	8.5	13.3

TABLE 18A

BOD REMOVAL CALCULATIONS

LAGOON #4 - PERFORMANCE AFTER TOMATO PACK

DATE 1963	LAGOON DEPTH-IN.	LAGOON VOLUME-GAL.	LAGOON SURFACE-FT^2	BOD-PPM EFFLUENT	LAGOON BOD-LB	BOD - LB/DAY EFFLUENT	BOD - LB/DAY BIO-REMOVAL	DISS. O_2 CONC.-PPM	REMARKS
Oct. 19	39½	32,000	1,107	38	12.2	0.4	2.8	4.4	
20	39	31,200	1,100	29	9.0	"	3.4	3.2	
21	36	27,300	1,050	19	5.2	"	-1.0	2.3	AVERAGE VOLUME LOSS
22	35	26,200	1,035	22	5.8	"	0.4	2.0	1,460 GALLONS/DAY
23	33	23,800	1,006	21	5.0	"	-1.3	6.2	
24	33	23,800	1,006	25	5.9	"	-4.5	7.0	
25	32	22,800	992	44	10.0	"	0.7	9.5	
26	31	21,800	978	41	8.9	0.2	-1.3	10.8	
27	31	21,800	978	46	10.0	"	2.5	10.2	
28	29	19,700	950	37	7.3	"	-0.8	8.1	AVERAGE VOLUME LOSS
29	29	19,700	950	40	7.9	"	0.9	5.5	600 GALLONS/DAY
30	28	18,500	938	37	6.8	"	0.5	10.1	
31	28	18,500	938	33	6.1	"	2.2	8.6	
Nov. 1	28	18,500	938	20	3.7	"	-	6.9	
2	27	17,600	924	-	-	-	-	7.5	
3	27	17,600	924	-	-	-	-	3.1	
4	27	17,600	924	-	-	-	-	7.6	AVERAGE VOLUME LOSS
5	27	17,600	924	-	-	-	-	12.2	NIL
6	27	17,600	924	-	-	-		13.3	
AVERAGE	32¼	23,290	998	32	7.4	0.3	0.35	6.8	AVERAGES FROM OCT. 19 TO NOV. 1

APPENDIX A

TABLE 19

RESULTS OF % VOLATILE SOLIDS AND NUTRIENTS - CANNERY WASTES

- TR - TRACE
- GRAB SAMPLES DENOTED BY G

DATE 1963	% VOLATILE SOLIDS TOTAL	SUSP.	DISS.	NITROGENS AS N, PPM FREE NH_3	TOTAL KJELD.	NO_2	NO_3	PHOSPHATES AS PO_4 PPM	
PEA WASTES									
June 28	58.0	69.0	50.0	0.49	41	0	TR	23.5	G
28	53.4	64.0	51.0	9.0	34	TR	TR	18.0	
July 3	54.9	52.3	60.5	2.1	7.7	TR	0	48.0	G
10	61.0	70.2	57.7	5.2	45	0	0.05	19.0	G
17	36.8	52.4	32.4	5.3	5.9	TR	0	3.5	G
TOMATO WASTES									
Aug. 21	63.4	33.4	64.7	0.16	1.4	0	0	3.6	G
29	56.3	90.4	51.0	0.13	9.9	0	TR	20.0	G
Sept. 4	45.0	65.2	38.5	0.08	8.3	0	TR	5.0	
12	37.0	35.8	37.2	0.26	6.1	0	TR	8.5	
18	49.6	74.8	39.5	0.23	10.0	TR	0	9.0	
25	34.3	56.1	29.0	0.13	6.1	0	TR	2.1	
Oct. 10	31.7	30.2	34.8	0.35	15.0	0	TR	24.0	G
10	31.6	27.9	36.9	0.32	13.0	0	TR	18.0	G
10	54.6	53.9	52.8	0.64	36	0	TR	29.0	G
16	71.4	89.3	53.9	2.90	3.3	0	TR	13.0	G
17	67.0	86.4	55.4	3.60	26	0	TR	8.5	G
17	54.2	82.8	45.6	2.90	26	0	TR	9.0	

TABLE 20

RESULTS OF % VOLATILE SOLIDS AND NUTRIENTS - AERATED LAGOON #1

- TR - TRACE
- GRAB SAMPLES DENOTED BY G

DATE 1963	% VOLATILE SOLIDS TOTAL	SUSP.	DISS.	NITROGENS AS N, PPM FREE NH_3	TOTAL KJELD.	NO_2	NO_3	PHOSPHATES AS PO_4 PPM	
June 28	42.7	66.7	41.0	1.3	5.9	TR	TR	3.0	G
July 3	60.6	16.7	67.0	1.0	7.4	0	TR	3.0	G
10	36.2	94.0	32.0	5.2	9.4	TR	0.1	7.0	G
17	32.5	17.7	33.5	8.6	10.0	0	TR	6.0	G
Aug. 1	25.8	23.3	26.1	7.0	9.9	0.03	TR	4.9	G
7	28.8	7.3	31.4	5.8	6.6	0.5	0	3.0	G
14	29.4	16.7	30.0	0.16	3.1	1.2	0.3	1.4	G
21	32.6	72.7	29.5	0.16	2.6	0.6	0.06	1.9	G
29	26.6	25.6	25.7	0.29	2.3	0.02	TR	2.0	G
Sept. 4	25.1	41.7	23.0	0.05	3.1	0	0	3.0	
12	14.8	44.4	12.1	0.13	2.3	0	TR	5.5	
18	29.8	61.1	28.0	0.20	2.8	TR	0	3.5	
25	26.3	33.3	26.3	0.05	2.8	0	0	1.2	
Oct. 10	36.5	25.5	38.4	0.08	6.1	0	TR	7.5	
17	31.9	78.3	28.7	0.10	9.9	0	TR	8.0	
23	32.9	60.0	31.0	0.13	9.4	0	TR	6.0	G
Nov. 29	39.2	37.5	39.5	0.77	6.8	TR	13	7.0	G

APPENDIX A

TABLE 21

RESULTS OF % VOLATILE SOLIDS AND NUTRIENTS - AERATED LAGOON #2

- TR - TRACE
- GRAB SAMPLES DENOTED BY G

DATE 1963	% VOLATILE SOLIDS TOTAL	SUSP.	DISS.	NITROGEN AS N, PPM FREE NH_3	TOTAL KJELD.	NO_2	NO_3	PHOSPHATES AS PO_4 PPM	
June 28	41.3	77.8	38.3	1.1	6.8	0.02	TR	3.5	G
July 3	68.0	28.6	68.9	5.3	11.0	0	TR	3.5	G
10	40.0	66.7	37.2	2.6	11.0	TR	TR	7.0	G
17	36.3	31.2	36.6	8.6	14.0	0	TR	6.0	G
Aug. 1	25.4	6.3	26.3	5.8	8.1	1.2	0.05	4.1	G
7	29.6	39.5	28.5	1.6	1.7	1.5	1.0	3.0	G
14	30.6	57.7	26.2	0.19	3.1	0.45	TR	1.6	G
21	26.6	30.6	26.4	0.19	8.4	0.5	TR	2.6	G
29	31.1	50.0	27.7	0.08	3.6	0	0	3.5	G
Sept. 4	31.0	51.2	28.1	0.05	4.0	0	TR	3.5	
12	34.6	55.5	33.3	0.04	2.8	0	0	6.0	
18	33.0	48.0	31.7	0.20	3.6	TR	0	4.5	
25	27.5	41.6	26.4	0.08	4.0	0	TR	2.5	
Oct. 10	37.5	84.1	31.3	0.32	7.4	0	TR	7.5	
17	28.9	85.2	24.4	0.06	10.0	TR	TR	7.5	
23	26.6	16.7	28.0	0.29	9.9	0	TR	6.0	G
Nov. 29	44.4	80.7	38.2	0.06	5.9	TR	TR	5.0	G

APPENDIX A

TABLE 22

RESULTS OF % VOLATILE SOLIDS AND NUTRIENTS - MECHANICALLY AERATED LAGOON, #3

- TR - TRACE
- GRAB SAMPLES DENOTED BY G

DATE 1963	% VOLATILE SOLIDS			NITROGENS AS N, PPM				PHOSPHATES AS PO4 PPM	
	TOTAL	SUSP.	DISS.	FREE NH_3	TOTAL KJELD	NO_2	NO_3		
June 28	48.5	49.0	48.0	3.3	34	TR	TR	18.5	G
July 3	57.7	32.0	73.2	1.1	37	TR	TR	18.5	G
10	43.4	58.1	29.5	9.8	84	0.04	TR	21.5	G
17	31.8	65.3	17.5	4.0	36	TR	0	15.5	G
17	28.2	54.6	17.6	3.6	43	TR	0	16.0	G
Aug. 1	21.7	53.0	11.4	1.6	22	1.2	0.05	16.0	G
7	25.7	51.0	18.8	0.7	8.3	0.8	6.3	14.0	G
14	25.9	39.2	23.1	0.16	5.9	0.45	3.0	5.9	G
21	31.0	60.8	22.4	0.05	10.0	0	0	10.5	G
29	50.0	8.4	39.8	0.11	18	0	TR	14.5	G
Sept. 4	41.2	64.5	33.6	0.03	12	0	0	8.5	
12	32.1	59.0	24.9	0.04	7.4	0	TR	14.0	
18	46.1	48.4	45.7	0.17	9.4	TR	TR	11.0	
25	28.4	41.2	25.7	0.13	6.8	0	0	3.3	
Oct. 10	51.6	73.3	43.8	0.58	21	0	TR	15.0	
17	35.6	74.5	27.3	0.13	19	TR	TR	13.5	
23	36.2	57.5	31.4	1.6	13	TR	TR	9.0	G
Nov. 29	73.5	45.8	75.8	0.51	8.7	0.01	0	6.0	G

APPENDIX A

TABLE 23

RESULTS OF % VOLATILE SOLIDS AND NUTRIENTS - WASTE STABILIZATION POND, #4

- TR - TRACE
- GRAB SAMPLES DENOTED BY G

DATE 1963	% VOLATILE SOLIDS			NITROGENS AS N, PPM				PHOSPHATES AS PO_4 PPM	
	TOTAL	SUSP.	DISS.	FREE NH_3	TOTAL KJELD	NO_2	NO_3		
June 28	50.5	67.7	49.8	0.49	24	TR	TR	11.5	G
July 3	61.7	16.1	66.9	6.6	21	TR	0	8.0	G
10	40.4	96.5	35.3	7.9	19	0	TR	11.0	G
17	56.3	91.3	46.4	6.6	43	0	TR	32.0	G
Aug. 1	22.6	45.0	21.3	0.29	8.1	0	0	4.0	G
14	24.6	10.0	25.0	3.2	7.3	0.04	0	3.5	G
21	31.5	56.5	28.0	1.1	8.1	0.8	TR	4.7	G
29	32.0	63.6	30.3	1.6	6.1	0.06	TR	2.5	G
Sept. 4	23.2	26.7	22.9	0.7	5.9	0	0	3.0	
12	29.1	36.6	28.7	0.38	4.8	0	TR	5.0	
18	33.6	16.7	34.1	0.2	4.8	TR	TR	4.5	
25	23.9	100	21.2	0.9	4.0	TR	TR	2.9	
Oct. 10	29.4	83.4	25.7	0.51	2.5	0	TR	6.0	
17	25.7	16.7	26.3	0.19	3.6	TR	TR	5.0	
23	28.7	51.8	26.8	0.19	3.5	0	TR	2.5	G
Nov. 29	43.0	38.9	43.4	0.06	14.0	TR	0.2	8.0	G

APPENDIX A

TABLE 24

ALGAE COUNTS - AERATED LAGOON #1

* ASU = AREAL STANDARD UNITS

DATE 1963	TOTAL ALGAE/ML ASU*	ALGAE GROUP	ALGAE PREDOMINANT TYPES	PROTOZOA NUMBER	PROTOZOA TYPE
June 28	38,000	Green	Chlorella	-	
July 10	500	Green	Oocystis	500	Paramecium
Aug. 8	3,400	Green	Scenedesmus	-	
		Flagellates	Chlamydomonas		
14	8,700	Diatoms	Nitzschia	-	
29	31,000	Green	Anacystis	-	
		Blue-Green	Gloeocystis		
Sept. 4	24,000	Diatoms	Synedra	800	Unknown
		Green	Gloeocystis		
12	30,000	Green	Chlorella	1700	Unknown
		Diatoms	Synedra		
18	19,000	Green	Chlorella-Type	-	
		Diatoms	Synedra		
25	21,000	Green	Selenastrum	4100	Vorticella
		Diatoms	Nitzschia		
Oct. 2	19,000	Greens	Oocystis	3300	Vorticella
		Diatoms	Nitzschia		
		Flagellates	Chlamydomonas		
10	13,000	Flagellates	Chlamydomonas	400	Unknown
17	12,000	Greens	Chlorella-Type	800	Unknown
24	82,000	Greens	Chlorella-Type	-	
Nov. 5	78,000	Greens	Chlorella-Type	-	

APPENDIX A

TABLE 25

ALGAE COUNTS - AERATED LAGOON #2

* ASU = AREAL STANDARD UNITS

DATE 1963	TOTAL ALGAE/ML ASU*	ALGAE GROUP	ALGAE PREDOMINANT TYPES	PROTOZOA NUMBER	PROTOZOA TYPE
June 28	21,000	Flagellates	Chlamydomonas	1800	Ciliates
July 10	94,000	Green	Scenedesmus	1900	Ciliates
Aug. 8	6,000	Diatoms	Synedra	-	
14	12,000	Green	Chlorella-Type	-	
29	16,000	Blue-Green	Oscillatoria	-	
Sept. 4	24,000	Diatoms	Synedra	800	Unknown
		Green	Chlamydomonas		
12	29,000	Diatoms	Synedra	800	Unknown
		Green	Chlorella-Type		
18	32,000	Green	Chlorella-Type	3300	Unknown
		Diatoms	Synedra		
25	3,000	Diatoms	Nitzschia	350	Vorticella
		Green	Pediastrum		
Oct. 2	17,000	Green	Selenastrum	3000	Vorticella
10	14,000	Flagellates	Chlamydomonas		
17	18,000	Green	Scenedesmus	800	Unknown
24	34,000	Green	Chlorella-Type	800	Ciliates
Nov. 5	83,000	Green	Chlorella-Type	-	
29	44,000	Green	Chlorella-Type	1600	Vorticella

APPENDIX A

TABLE 26

ALGAE COUNTS - MECHANICALLY AERATED LAGOON #3

* ASU = AREAL STANDARD UNITS

DATE 1963	TOTAL ALGAE/ML ASU*	ALGAE GROUP	ALGAE PREDOMINANT TYPES	PROTOZOA AND OTHERS NUMBER	PROTOZOA AND OTHERS TYPE
June 28	7,000	Green	Chlorella-Type	1800	Ciliates
July 10				Abundant	Sphaerotilus
Aug. 8	6,000	Diatoms	Nitzschia	Abundant	Sphaerotilus
29	14,000	Diatoms	Scenesdesmus		
Sept. 4	Abundant	Blue-Green	Nostoc	1400	Ciliates
12	500	Green	Ankistrodesmus	3000	Vorticella
				Abundant	Sphaerotilus
18	1,000	Flagellates	Chlamydomonas	600	Vorticella
25	600	Green	Scenedesmus	250	Vorticella
Oct. 2	12,000	Blue-Green	Gloeocapsa	250	Vorticella
10	2,000	Flagellates	Chlamydomonas	20,000	Unknown
				Abundant	Sphaerotilus
17	2,000	Flagellates	Euglena	100	Vorticella
					Sphaerotilus
24	2,000	Flagellates	Chlamydomonas	1500	Vorticella
Nov. 5	1,000	Green	Ankistrodesmus	1300	Ciliates
29	53,000	Green	Chlorella-Type	-	
		Flagellates	Euglena		

APPENDIX A

TABLE 27

ALGAE COUNTS - WASTE STABILIZATION POND #4

* ASU = AREAL STANDARD UNITS

DATE 1963	TOTAL ALGAE/ML ASU*	ALGAE GROUP	ALGAE PREDOMINANT TYPES	PROTOZOA NUMBER	PROTOZOA TYPE
June 28	18,000	Flagellates	Chlamydomonas	-	
July 10	45,000	Green	Chlorella-Type		
Aug. 8	16,000	Green	Chlorella-Type		
14	2,000	Green	Ankistrodesmus		
29	15,000	Green	Scenedesmus		
Sept. 4	14,000	Blue-Green	Chroococcus	4000	Ciliates
12	13,000	Green	Oocystis	3000	Vorticella
18	14,000	Green	Gloeocystis	1200	Vorticella
25	22,000	Green	Oocystis	5000	Unknown
Oct. 2	27,000	Green	Oocystis	4000	Ciliates
		Flagellates	Chlamydomonas		
10	49,000	Green	Oocystis	-	
17	44,000	Green	Oocystis		
24	68,000	Green	Oocystis		
		Flagellates	Chlamydomonas		
Nov. 5	177,000	Green	Chlorella-Type		
29	257,000	Green	Chlorella-Type		

APPENDIX A

TABLE 28

COMPARATIVE SUMMARY OF BOD REMOVAL AND AIR SUPPLY DATA

OPERATIONAL PHASE OF STUDY	LAGOON DEPTH-IN	SURFACE AREA FT^2	DISS. O_2 PPM	EFFLUENT BOD-PPM	BOD APPLIED		BOD REMOVED			AIR SUPPLY	
					LB/DAY	LB/DAY/ACRE	LB/DAY	LB/DAY/ACRE	% OF APPLIED	FT^3/DAY	FT^3/DAY/ACRE
PEA PACK											
LAGOON #1	59¼	8,050	2.9	36	27.5	149	26.3	142	95.4	8,290	44,800
LAGOON #2	60½	7,960	3.9	37	28.4	155	27.4	150	96.5	18,240	99,800
LAGOON #3	85¾	750	3.2	192	55.9	3,250	33.2	1,930	59.5	(0.96 BHP)*	(0.96 BHP)*
LAGOON #4	34¼	1,032	3.9	95	5.76	242	3.96	167	68.8	NIL	NIL
BETWEEN PEA AND TOMATO PACKS											
LAGOON #1	70½	8,900	6.9	18	1.30	6.35	1.45	7.01	112	2,870	14,000
LAGOON #2	69	8,610	7.4	23	1.49	7.55	0.88	4.45	59.0	19,800-	100,000-
LAGOON #3	84¼	737	7.1	90	4.27	25.2	2.38	14.05	55.7	(0.96 BHP)*	(0.96 BHP)*
LAGOON #4	38	1,077	3.5	48	0.060	2.43	0.068	2.75	113	NIL	NIL
TOMATO PACK											
LAGOON #1	83	9,893	3.6	37+	77	339	61	268	79.3	2,000-	8,800-
LAGOON #2 27/8 to 18/9	69	8,580	4.8	19	23.5	119	21.6	110	91.8	(5,000)	(25,400)
LAGOON #2, 19/9 to 8/10(est)	(92½)	(10,430)	2.2	59+	144.2	602	125±	521±	86.6	(11,000)	(45,900)
LAGOON #2, Overall estimates	(82)	(9,500)	3.4	42+	92.0	423	83±	367±	87.2	(8,400)	(38,500)
LAGOON #3	90	797	6.6	135	177.5	9,700	60.6	3,310	34.1	(0.96 BHP)*	(0.96 BHP *
LAGOON #4	39	1,100	6.5	40	1.81	71.6	0.85	33.6	46.8	NIL	NIL

OPERATIONAL PHASE OF STUDY	LAGOON DEPTH-IN	SURFACE AREA FT3	DISS. O_2 PPM	EFFLUENT BOD-PPM	BOD APPLIED		BOD REMOVED			AIR SUPPLY	
					LB/DAY	LB/DAY/ACRE	LB/DAY	LB/DAY/ACRE	% OF APPLIED	FT /DAY	FT /DAY/ACRE
FOLLOWING TOMATO PACK											
LAGOON #1	86½	10,180	2.4	91	0	0	13.4	57.3	-	(2,880)	(12,300)
LAGOON #2	87½	10,000	2.9	73	0	0	(30)	130.6	-	(7,000-)	(30,500-)
LAGOON #3	88½	775	8.2	39	0	0	(27.6)	1544	-	(0.96 BHP)*	(0.96 BHP)*
LAGOON #4	32¼	998	6.8	32	0	0	0.35	15.3	-	NIL	NIL

* Simcar mechanical aerator rotor rated at 4 lb. oxygen per hour per BHP in deaerated tap water at 20° C

(---) Estimated value indicated +, -, ± Value within an estimated 10% in indicated directions

APPENDIX A

TABLE 29

NUTRIENT COMPARISON TABLE - (MAIN BASIS - WEEKLY SAMPLING)

CONCENTRATION IN PARTS PER MILLION

STUDY PHASE	SUSPENDED VOLATILE SOLIDS	DISSOLVED SOLIDS		BOD	NITROGEN AS N		PHOSPHATE AS PO4	PH
		TOTAL	VOLATILE		TOTAL KJD.	FREE NH3		
RAW WASTES								
PEAS	188	1044	526	626	26.7	4.4	22.4	7.3
TOMATOES	208	1021	458	520	13.4	0.98	13.4	7.85
PEA PACK								
LAGOON #1	44	514	223	36	8.2	4.0	4.7	7.6
#2	45	523	237	37	10.7	4.4	5.0	7.7
#3	178	715	222	192	46.8	4.55	18.0	7.8
#4	75	633	314	95	26.8	5.6	15.6	8.4
BETWEEN PACKS								
LAGOON #1	11	597	174	18	5.6	3.3	2.8	8.2
#2	28	592	159	23	5.3	2.0	2.8	8.3
#3	122	827	156	90	11.5	0.64	11.6	8.2
#4	43	677	168	48	7.8	1.53	5.4	8.6
TOMATO PACK								
LAGOON #1	31	615	164	37+	4.2	1.3	4.4	8.2
#2	42	618	179	19	5.6	0.12	5.0	7.9
#3	110	665	229	135	13.4	0.17	11.4	8.5
#4	26	734	198	40	4.5	0.64	4.1	9.0
AFTER TOMATO PACK								
LAGOON #1	54	670	237	91	8.1	0.45	6.5	7.8
#2	50	669	222	73	7.9	0.17	5.5	8.1
#3	92	686	368	39	10.9	0.66	7.5	8.1
#4	47	704	247	32	12.6	0.13	5.3	8.4

14. APPENDIX B

APPENDIX B

AERATION TUBING

Throughout this report, the writer has continually made reference to the fact that the aeration tubing as supplied by Hinde Engineering Company, Chicago, under the trade name of Air-Aqua, presented many operational problems throughout this study. After three weeks operation at Chatham, and every two to three weeks thereafter throughout the study, it was necessary to clear the tubing using a portable compressor to feed air under about 40 psig pressure into each of the air laterals. Other methods for maintaining clear air holes were not attempted at this time.

Because of the problems being experienced in the study, it was decided to carry out some tests at the OWRC Laboratories.

TEST 1 - VALVES

According to the manufacturer the description of the aeration tubing is as follows: (Hinde Engineering Company, Bulletin 500) quote "Specially-formulated polyethylene; machine processing die-forms thousands of check valves which release bubbles of optimum size for maximum oxygen transfer, and control of circulation and mixing. Continuous strip of lead "keel" encapsulated with flexible sheath keeps check valves correctly positioned on bottom of lagoon". Furthermore the literature describing some installations (Water & Sewage Works, October, 1963) makes reference to the fact that air is released through non-clogging die-formed check valves.

A close inspection of the tubing showed that the air release holes consisted of "slits", similar to punctures made by a sharp knife. These "slits" were spaced at a distance of 1-5/8 inch, centre to centre. Therefore, the writer has referred to the tubing as perforated air tubing rather than die-formed check valves. It was found that the "slits" could be sealed by the use of a soldering iron. A ten-foot section was sealed by this method and it withstood 35 pounds of air pressure. Volume of a ten-foot section was found to be 397 ml.

TEST 2 - WATER INFILTRATION

In an attempt to determine the efficiency of the check valves, a ten-foot section of new tubing was placed in a tank of water with 3.5 feet of head. This tubing was vented to atmosphere. The tubing was allowed to remain in the tank for various periods of time and then removed, and the amount of water in the tubing was measured. The results were as follows:

Time in 3.5 ft. of water (min.)	Volume of Water found in tubing (ml)	Per cent of tubing filled
1	150	37.8
2	220	55.4
5	310	78.2
10	310	78.2
30	328	82.7
60	327	82.5
4 hours	330	83.2

The above table clearly indicates that the air tubing fills with water fairly rapidly. In a full-scale application, the use of check valves on the air header pipe could possibly reduce the amount of water entering the tubing. However, in the study at Chatham, no check valves were used and therefore, a fair amount of water would have entered the tubing because the blower was stopped regularly for maintenance checks.

The presence of the water in the tubing results in greater air pressures because of the reduced volume through which the air could travel. Also, the lagoon water contained considerable suspended solids which would inevitably result in some clogging of the air holes.

The prevention of water entering the tubing and the maintaining of clear air holes is a prerequisite of this type of tubing for its use in Chatham because of the seasonal operation to be encountered.

TEST 3 -

(a) TEST-REPRODUCED SCALING

In order to indentify the cause of air pore clogging more exactly and to develop practical counter-measures against the problem, an indoor test study was set up to reproduce certain lagoon parameters noted at Chatham. Four 300 gallon, 3-1/2 foot deep tank environments were set up starting with Toronto tap water. The sections were aerated with Air-Aqua type hose and were equally loaded with organic wastes consisting of sewage and comminuted waste vegetables, largely tomatoes. Two of the tanks were prepared with a limestone soil bottom, and a coarser limestone gravel was laid on the bottom of the third. One of the soil-lined tanks was intensely illuminated with a battery of 8 Gro-lux fluorescent lamps overhead to encourage algal growth upon seeding.

Although not all of the tubing sections clogged to the same degree, the air line header supplying the four tanks gradually developed an increased back pressure beginning after two weeks operation. In eight weeks the pressure steadily mounted from an initial 3 psi to 12 psi. The plugging developed in the algal-stimulated tank exceeded the development in the other three tanks, while the tank without soil or limestone addition showed the least symptoms of plugging up to that time. Microscopic examination of the clogged hose sections showed close similarity with hose observed from the Chatham lagoon site. Generally the inside of the tube remained clean, while the pores themselves became blocked with very minute quantities of acid-soluble scale. Approximately 2 mgm of scale material was recovered from 300 slit holes for an attempt to chemically analyze this material.

(b) SCALING HYPOTHESIS

The observations and a few theoretical calculations tended to indicate that the basic mechanism of this scale formation began in the layer of organic bottom sludge, which as it decomposed, formed a quantity of localized acidity. This sludge acidity leached calcium carbonate out of the contacted soil and delivered it to the water body in general until the water became fully saturated with calcium hardness ion.

(Hardness rose from below 200 ppm to above 420 ppm in some of the tank tests). The utilization of carbon dioxide by algal growth assisted in the development of hardness ion saturation (or supersaturation) due to the removal of this acidic material capable of maintaining hardness scale solubility.

Once the water became saturated with respect to any significantly soluble compound, such as calcium carbonate, then the evaporation of any amount of solution resulted in precipitation of some of the saturating material. Much of this precipitated material would be expected to become crystallized about the sites of air application. While the evaporation of such water may seem to be a relatively small amount, the actual quantity of scale involved in the plugging also proved to be of a corresponding magnitude.

(c) CLEANING TRIALS

As the scale exhibited easy solubility in hydrochloric acid, laboratory scale application of this acid was made upon some of the clogged tubing. The acid was injected as as atomized spray into the air feed. While a spray application of 1 cc of 35% hydrochloric acid per foot of tubing seemed to be required, this value may have been excessive as it was noted that the atomizer injector was leaking and undoubtedly wasting some of the acid feed during applications. The recovery of aeration capacity upon treatment of 10 foot lengths of even the most clogged tubing appeared to approach 100%. In this test it was also noted that mechanical flexing of such tubing tended to produce some improvement even without acid treatment. Evidently such flexing tended to break up the scale plugging the air holes.

As a follow up, a parallel but larger scale cleaning treatment was attempted during March 1964 on clogged tubing present in the Chatham lagoons not treated by chlorine the previous fall. The results indicated that this tubing could also be cleaned; however, a distribution problem developed regarding the atomized acid being applied. The tubing holes nearest the air supply header cleared out quickly, but from thereafter much of the continued acid application was obviously wasted out the holes already cleared. In essence, the blind ends of the aeration tubing parallels did not receive adequate treatment acid.

(d) CONCLUSIONS

It must be anticipated that any aeration system employed in a water that has developed a solution saturation with respect to some significantly soluble substance will run into clogging difficulties. This instance of a perforated aeration hose proved to be particularly susceptible. In this soil-bottomed lagoon, the wastes by chemical interaction with the bottom mud were able to develop a calcium carbonate saturation at relatively high salt concentrations.

The fact that calcium carbonate predominates over any other substances in the development of the scale problem makes this scale conveniently removable by hydrochloric acid. It is likely however that phosphate, iron, silicates, and other materials in solution saturation contribute to this scale as well. Should the calcium carbonate component be inhibited, the rate of scale formation would be greatly reduced, but on the other hand, the removal of the scale might be made more difficult, particularly by hydrochloric acid.

In a full-sized lagoon operation, it might be expected that the rate of scale-up may diminish in a lagoon system having a continuous overflow. It is believed that the lack of an overflow at the Chatham pilot units promoted the development of carbonate scale saturation in the impounded water. Generally speaking it could also be expected that any rate of scale that does develop would tend to diminish over the years as leachable soil minerals are used up from the lagoon bed and carried out the outfall.

The results on acid cleaning of the aeration hose suggests that such aeration grids should be constructed of materials that are as chemically inert as possible, particularly to acid attack. Mechanical flexibility, particularly in response to air pressure variation, would seem to be desirable in a hose system for assisting in the flaking off of looser scaling particles. For chemical treatment efficiency against scaling problems, the layout of aeration tubing must avoid blind ends with relation to any single air supply header.

TEST 4 - DESIGN CONSIDERATION

To determine whether a different design of the tubing would alleviate the infiltration and scale clogging problems encountered during the operation of the pilot plant, a number of tank studies were carried out on commercially available plastic hose. The most promising results were obtained using a flat type, heavy gauge, lawn soaker hose. The flexibility allowed collapse of the tubing when air pressure was released and prevented or reduced entry of water. A filler used in compounding the plastic had the advantage of producing a tacky or sticky feeling to the hose which probably allowed more efficient sealing of the air pores when closed.

For practical use, it is considered such a diffused air tubing should be constructed of such a thickness and material composition to allow a flexing action when air pressure is released and with the air pores along each side to provide easier escape of infiltrated water.

In addition, the complete system should include an injection system for regular dosing with hydrochloric acid as a preventative measure to reduce or eliminate build up of scale in the air pores. A check valve should be installed on the pressure side of the blower so that no reverse flow of air can take place when the blower is off.

DATE DUE
